OCTOBER, 1955

# modern castings

## *and* American Foundryman

*Owned by* THE MEN WHO BUY

**Solving Hot Cracks Headache**

The malleable iron was too refined and the sand too good an insulator

**Cupola Sports New Bonnet**

Wisconsin design helps the university foundry live with its close neighbors

**$uggestion System Pays Off**

Ford Motor Company's suggestion plan is aided by strong management interest

**Chain Casting Secrets**

Every other link is precast; then the connecting links are cast vertically

**Give it a Shot in the Ladle!**

Injection in the ladle can quickly give controlled increases of up to 1% carbon

**No Need for Rat Tails**

Costly nuisance can be eliminated by proper controls and sand selection

**SHELL MOLDING**

16-page bonus section of ideas for the practical foundryman

## future meetings and exhibits

### OCTOBER

6-7 . . National Foundry Association, *Edgewater Beach Hotel, Chicago. Fifty-seventh Annual Meeting.*

13-15 . . Foundry Equipment Manufacturers Association, *The Greenbrier, White Sulphur Springs, W. Va. Annual Meeting.*

13-15 . . Committee on Vacuum Techniques Inc., *Mellon Institute, Pittsburgh. Symposium on vacuum technology.*

14-15 . . New England Regional Foundry Conference, Massachusetts Institute of Technology, Cambridge. Sponsored by the New England Foundrymen's Association in cooperation with MIT.

14-15 . . Northwest Regional Foundry Conference, *Multnomah Hotel, Portland Ore. Sponsored by the British Columbia, Oregon, and Washington chapters of the American Foundrymen's Society and the Oregon State College Student Chapter.*

16-18 . . Conveyor Equipment Manufacturers Association, *The Greenbrier, White Sulphur Springs, W. Va. Annual Meeting.*

17-18 . . American Coke and Coal Chemicals Institute, *The Greenbrier, White Sulphur Springs, W. Va. Annual Meeting.*

17-21 . . National Safety Congress and Exposition. *Chicago, Ill. Forty-third Annual Congress*

17-21 . . American Society for Metals, *Convention Hall, Philadelphia. National Exposition and Congress.*

18 . . American Society of Safety Engineers, *Conrad Hilton Hotel, Chicago. Annual Meeting.*

19-21 . . Gray Iron Founders' Society, *Hotel Schroeder, Milwaukee. Twenty-seventh Annual Meeting.*

20-21 . . Ohio Regional Foundry Conference, *Case Institute of Technology, Cleveland. Sponsored by the Northeastern Ohio, Toledo, Canton District, Central Ohio, and Cincinnati District Chapters of AFS in cooperation with Case Institute of Technology.*

20-21 . . Sixth Annual National Noise Abatement Symposium, *Armour Research Foundation of Illinois Institute of Technology, Chicago.*

24-25 . . Steel Founders' Society of

America, *The Greenbrier, White Sulphur Springs, West Virginia. Fall Meeting.*

24-26 . . Sixth National Conference on Standards, *Sheraton-Park Hotel, Washington, D. C. Sponsored by the National Bureau of Standards and the American Standards Association.*

31-Nov. 1 . . Magnesium Association, *Biltmore Hotel, New York. Annual Meeting.*

NOVEMBER

1-3 . . Grinding Wheel Institute and Abrasive Grain Association, *Statler Hotel, Buffalo. Fall Meeting.*

1-3 . . Investment Casting Institute, *Sheraton-Cadillac Hotel, Detroit. Annual Fall Meeting.*

3-4 . . Metals Casting Conference, *Purdue University, West Lafayette, Ind. Sponsored by the Central Indiana and Michiana Chapter of AFS in cooperation with Purdue University.*

13-18 . . American Society of Mechanical Engineers, *Congress, Conrad Hilton, and Sheraton-Blackstone Hotels, Chicago. Diamond Jubilee Annual Meeting.*

14-17 . . International Automation Exposition, *Navy Pier, Chicago.*

16-18 . . Steel Founders' Society, *Hotel Carter, Cleveland. Annual Technical and Operating Conference.*

17-18 . . American Society for Quality Control, *Schroeder Hotel, Milwaukee. Tenth Mid-West Conference.*

18-19 . . New York State-Canada-Pennsylvania Regional Foundry Conference, Onondaga Hotel, Syracuse, N. Y. *Sponsored by Central New York, Eastern Canada, Eastern New York, Rochester, Western New York, Northwestern Pennsylvania and Ontario Chapters of the American Foundrymen's Society.*

DECEMBER

1-2 . . Michigan Regional Foundry Conference, *Michigan State University, East Lansing, Mich. Sponsored by the Detroit, Saginaw Valley, Central Michigan and Western Michigan Chapters of the American Foundrymen's Society and the Michigan State University and University of Michigan Student Chapters.*

7-9 . . American Institute of Mining and Metallurgical Engineers, *Hotel William Penn, Pittsburgh. Electric Furnace Steel Conference.*

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1956

23-26 . . Plant Maintenance & Engineering Show, *Convention Hall, Philadelphia.*

FEBRUARY

9-10 . . **Wisconsin Regional Foundry Conference,** *Schroeder Hotel, Milwaukee. **Sponsored by the AFS Wisconsin Chapter and the University of Wisconsin and the AFS Wisconsin Student Chapter.***

16-17 . . **Southeastern Regional Foundry Conference,** *Tutwiler Hotel, Birmingham, Ala. **Sponsored by the Birmingham District and Tennessee Chapters and the University of Alabama Student Chapter of American Foundrymen's Society.***

27-Mar. 2 . . American Society for Testing Materials, *Statler Hotel, Buffalo. 1956 Committee Week.*

MARCH

7-8 . . Foundry Educational Foundation, *Hotel Cleveland, Cleveland. College-Industry Conference.*

15-16 . . Steel Founders' Society of America, *Drake Hotel, Chicago. Annual Meeting.*

MAY

3 . . Non-Ferrous Founders' Society, *Atlantic City, Annual Membership Meeting.*

3-9 . . **American Foundrymen's Society,** ***Convention Hall, Atlantic City, N. J. 60th Annual Convention and Exhibit***

JUNE

5-8 . . Materials Handling Institute, *Public Auditorium, Cleveland. Materials Handling Exposition.*

10-12 . . Malleable Founders' Society, *The Homestead, Hot Springs, Va. Annual Meeting.*

17-22 . . American Society for Testing Materials, *Chalfonte-Haddon Hall, Atlantic City, N. J. 59th Annual Meeting.*

october 1955

vol. 28 no. 4

# modern castings

## and American Foundryman

### in this issue



### regular departments



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## TIPS, TRENDS AND TECHNIQUES

**Blown cores** bake on a 55-min. cycle in the continuous-type tower oven of Zenith Foundry Co., Milwaukee, shown on this month's cover. "Shaping accuracy from within" is the way they describe their careful core production techniques.

**Must be something** to the 56/100% impurities that soap company leaves in. Evidently you can carry a thing like purity too far. Excessively refined metal was one of the reasons for hot cracks headaches in a malleable shop (pages 30-36).

**$300 worth** of materials and labor reduced a fire hazard and eliminated smoke and fume emission of a small cupola. For how to do it and results obtained see pages 37-38.

**Suggestion systems** pay off for the company as well as for the employees but it takes management interest and participation to make them work. Here's how to set up a program and make it click (pages 39-40).

**Shell molding ideas** that will keep you out of trouble or lick your present problems make this month's Bonus Section a handbook all shell mold operators will use regularly. Pages 41-56 cover practical operating hints, trouble shooting, and risering.

**Tying chain links** together with molten metal looks simple enough after you see how they do it at Electric Steel Foundry Co. in Portland, Ore. Unique square cross-section link gives extra strength (pages 58-59).

**Carbon control** in the ladle with increases as high as 1% are now possible with a technique that gives you many irons in the ladle with only one base iron in the cupola (pages 60-64).

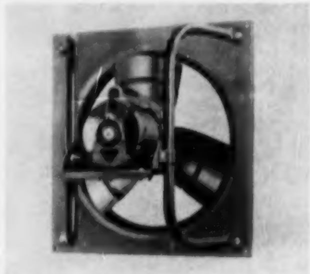
**Rat tails** are not a necessary evil nor are they inevitable. There are ways to avoid them and sand test methods to help predict rat-tailing tendencies of sand mixtures (pages 65-66).

**Next month** . . . vertical gating . . . how to treat gray iron . . . case history of a premium casting that saved $1½ million . . . red hot charcoal solves non-ferrous melting problem . . . are your short order prices hurting?

# products and processes

### Industrial Type Exhaust Fan

Model K Ventura Fan designed specifically for industrial installations, is available with 2-speed or constant

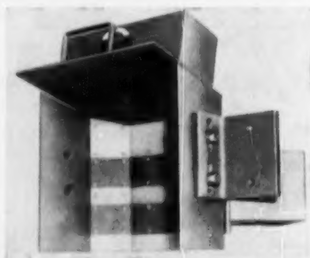


speed direct-drive totally-enclosed motors. Capacities range from 587 to 12,800 cfm. Operates against static pressures up to 5/8-in. *American Blower Corp.*

CIRCLE No. 1, PAGE 83-84

### Magnetic Reclamation Drum

Permanent magnetic Agitator Drum is used for separating small iron particles in the relamation of non-magnetic



turnings, boring, chips, and in similar processes where some agitation is needed to disentangle the iron and prevent excessive carry-over. *Eriez Mfg. Co.*

CIRCLE No. 2, PAGE 83-84

### Dimensionally Stable Mahogany

Stabilite, dimensionally stable, resin impregnated and laminated mahogany carving wood for patterns, is practically unaffected by humidity and temperature changes, according to bulletin. This "stay put" material has excellent carvability, machinability, paintability, and gluing quality. It resists decay, heat, acid, electricity, and checking. Available as lumber ¾ and 1 in. thick, 4-16 in. wide, and 4-8 ft long. *Aetna Plywood & Veneer Co.*

CIRCLE No. 3, PAGE 83-84

### Tractor Shovel Newcomer

Napco Loader, Model NL-5, front end loader has the following specs: 15 cu ft, 1250 lb lift to max of 7½ ft under bucket hinge, 35° bucket tiltback at ground level, front wheel


drive and rear wheel steering, 7 ft 4 in. turning radius to outside of bucket, no-clutch shifting for two forward and two reverse speeds, and full line of attachments. *Napco Industries, Inc.*

CIRCLE No. 4, PAGE 83-84

### Bin Level Indicator

New Roto-Bin-Dicator is a paddle-type bin level indicator for installation in bins under pressure or vacuum; bins, chutes, or conveyors handling materials containing large lumps which tend to bridge; and bins handling materials which tend to rat-hole. Bulletin available. *Bin-Dicator Co.*

CIRCLE No. 5, PAGE 83-84

### Simplified Fork Truck Controls

Simplified combination lever control operating fork hoist and mast tilt on Mobilift trucks reduces controls to four levers and two pedals and affords

higher operating efficiency and greater safety. *Lamson Mobilift Corp.*

CIRCLE No. 6, PAGE 83-84

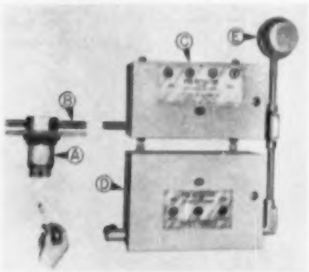
**Offers Wheels for Test**

Two mounted Chicago wheels, ¼-in. by ½-in. straight wheels on ⅛-in. mandrel are offered for actual job testing to demonstrate uniformity of size, shape, grain, grade, and abrasive bond. *Chicago Wheel & Mfg. Co.*

CIRCLE No. 7, PAGE 83-84

**Fire Detector**

New, radio-active automatic C-O-Two Pre-Detector System gives visual and audible alarms within seconds after the ignition of a fire and is particularly adaptable to protecting pattern stor-




age, according to 9-page bulletin A-62034. The system indicates location of the fire, can also alert public fire department and perform other functions to keep fire damage to a minimum. *Pyrene–C-O-Two.*

CIRCLE No. 8, PAGE 83-84

**Coining Press Guard**

A drop gate electric solenoid guard has been added to the Searjeant line of punch press safety equipment. It surrounds the die area when in the down position, eliminating the hazard of reaching in the ends. *Searjeant Metal Products Inc.*

CIRCLE No. 9, PAGE 83-84

**High Speed Mounted Wheels**

A new line of ADS high speed resin bonded aluminum oxide grain mounted wheels and points is designed to operate at 20,000 rpm and above. Coded to indicate the degree of hardness, they are available in standard grits from 24 to 120 and sizes and shapes conforming to national standards. *American Diamond Saw Sales*

CIRCLE No. 10, PAGE 83-84

**Core Drier Material**

New transfer-type plastic core drier compound, Stanley 84X-15, designed for di-electric ovens and recommended

for use with urea-bonded cores, is claimed to be easier to make, requires little or no hand finishing, is lower in cost than compression-molded driers and easier to handle. Also they have low thermal conductivity, high strength and abrasion resistance, and negligible shrinkage. Data available. *Stanley Chemical Co.*

CIRCLE No. 11, PAGE 83-84

### Portable Dust Collector

Dust-Pak, a new, completely portable package dust collecting system, combines centrifugal separation and fil-

tration, has drawer in base and "throw-away" filters for quick, easy disposal. Sizes are from 400 to 1000 cfm. *Schmieg Industries Inc.*

CIRCLE No. 12, PAGE 83-84

### Sand Slinger Magnet

Non-electric Sand Slinger Magnet is designed for installation at the discharge end of belt conveyors on various sand slingers handling sand at speeds of 375 fpm and quantities up to 2000 lb/min. Face plates subject to wear may be replaced without disturbing magnetic portions of the unit. *Eriez Mfg. Co.*

CIRCLE No. 13, PAGE 83-84

### Automatic Drive Fork Truck

New, simplified torque converter-type drive, Hystamatic Drive, is now offered for Hyster 3000-lb capacity UC-30 and 4000-lb capacity YC-40 lift trucks. The Hystamatic has latest design improvements with fewer moving parts than comparative models. Smooth flow of power eliminates engine lugging, cre-

CIRCLE No. 102, PAGE 83-84

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ating faster maneuverability and greater work output. Specifications in Form No. 1130. *Hyster Co.*

CIRCLE No. 14, PAGE 83-84

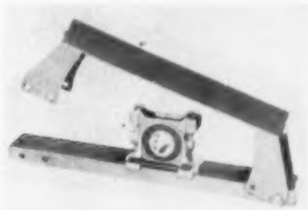
**New Metal Remelter**

New metal remelter for all alloys that melt below 1000 F is charged from the top and operates on gas, oil, or electricity. Depending on type of heat, unit takes two hours to melt a full pot from cold start. Recovery time for additional loads is one hour. Capacities range from 600 to 10,000 lb. *Nolan Corp.*

CIRCLE No. 15, PAGE 83-84

**Redesigned Conveyor Takeup**

New one-piece hinged top frame DS takeup permits easy access to the bearing block and adjusting screw. New arch-frame design adds strength. Interchangeable with previous designs, they are available with babbitted, ball, or roller bearings. Folder No. 2539. *Link-Belt Co.*



CIRCLE No. 16, PAGE 83-84

**Fork Truck with New Suspension**

Hydra-Lizer, new rear wheel suspension system on 2000 and 4000 lb Model D-424 and Model M-324 Mobilift fork trucks fully compensates for irregularities in floor surfaces up to 3 in. and in so doing, maintains equal distribution of weight of the truck and load. *Lamson Mobilift Corp.*

CIRCLE No. 17, PAGE 83-84

**Dust Collector on Casters**

Casters are now available on 17 Torit cabinet and cyclone types of individual collectors for dust, particles, and fumes. This permits easy, quick, and quiet movement of equipment from one job to another. *Torit Mfg. Co.*

CIRCLE No. 18, PAGE 83-84

**Primer for Magnesium**

Magnesium primer 40X-675 for spraying or dipping is fast-drying and has long lasting salt spray resistance. Is

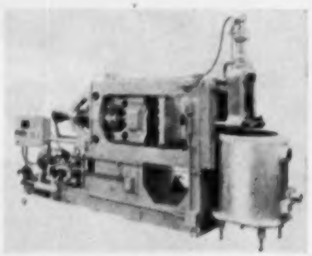
CIRCLE No. 103, PAGE 83-84

designed to check electrolytic decomposition where magnesium is joined to less active metal; also resists solvent action of hydraulic fluids. *Stanley Works.*

CIRCLE No. 19, PAGE 83-84

**Multi-Feature Die Casting Machine**

600-ton die casting machine, HP-3Z-SF, is designed to cast up to 15¼ lb of zinc or proportionate weights of lead or tin. Independent furnace is

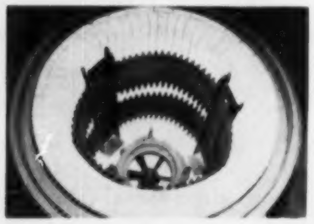


large. One machine is being used to cast a large area, multi-cavity die at an average rate of 280 shots/hr. *Lester-Phoenix, Inc.*

CIRCLE No. 20, PAGE 83-84

**New Electric Heating Element**

Corrtherm is an entirely new electric heating element for heat treating furnaces consisting of corrugated sheets of nickel chromium which practically cover the entire furnace walls. Accommodates amperage increase of 10-



20 times previous types. Greater surface results in lower surface temperatures and therefore longer element life. Voltage is so low that accidental contact cannot be felt. Also claimed is great ease in element replacement. *Lindberg Engineering Co.*

CIRCLE No. 21, PAGE 83-84

**Surface Pyrometer**

Land Surface Pyrometer is portable, measures temperatures in range of 100 to 2400 F of variety of surfaces regardless of emissivity, is accurate within 0.5 per cent. Concave instrument head creates nearly black body conditions. *Fielden Instrument Div., Robershaw-Fulton Controls Co.*

CIRCLE No. 22, PAGE 83-84

**Water and Slurry Dispenser**

No. 3906 Rapid Water and Slurry Dispenser may be used to add a pre-set amount of liquid to a batch-type sand mixer accurately and quickly. Tank fills automatically to set amount, then

upon signal, exhausts water by air pressure in a matter of seconds. Wet mulling time starts only after most of the water is added. *Harry W. Dietert Co.*

CIRCLE No. 23, PAGE 83-84

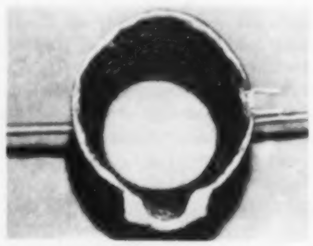
**Floor Repair Material**

Carbo-Tread J-176-C "Regular" is a ready-mixed granulated compound of hard, accurately-sized aggregates and processed asphalts. Easy to apply, gives tough resilient surface; 55-gal drum covers 200 sq ft ⅜ in. thick. Use for resurfacing or patching. *Maintenance Inc.*

CIRCLE No. 24, PAGE 83-84

**Graphite Plastic Ladle Lining**

New graphite plastic refractory, Silex P-21, is recommended for use in ferrous and non-ferrous foundries for malleable runners and spouts, tap holes, wells, and slag holes, for cupo-



las, and pouring ladles of all types. Claims to have high molten metal shock resistance and high slag resistance. *J. H. France Refractories Co.*

CIRCLE No. 25, PAGE 83-84

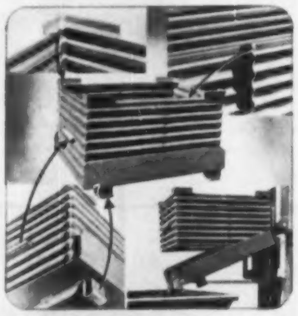
### Air Cylinders

S-P air cylinders have square-end, space-saving design, are available in 11 bore sizes from 1½ through 14 in. with 21 types of mountings. Designed to JIC standards. *S-P Manufacturing Corp.*

CIRCLE No. 26, PAGE 83-84

### Drop Bottom Box

New, corrugated, all-steel, welded drop-bottom boxes are made for use with positioning stand or for controlled dumping by fork truck. Boxes

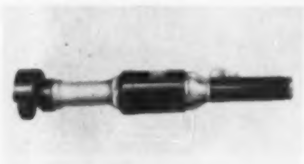


have four-way entrances and are built to customer specifications. *Palmer-Shile Co.*

CIRCLE No. 27, PAGE 83-84

### Horizontal Grinders

New general utility horizontal grinders feature built-in muffler for reducing noise, requires no special servicing tools. 3/8-24 spindle model takes 2½ x ½-in. organic wheel to 4 x ½-in.



viterous wheel; ½-13 spindle model takes 2½ x 1-in. to 6 x ½-in organic wheel; wire bushes or roll abrasives also. *Buckeye Tools Corp.*

CIRCLE No. 28, PAGE 83-84

### Portable Vibrator

New, lightweight, portable vibrator, developing 7000-8000 vibrations per minute, is said to be unusually well balanced and ideal for heavy duty use on portable bins, trucks, and large pipe forms that do not require permanent vibrators. *Cleveland Vibrator Co.*

CIRCLE No. 29, PAGE 83-84

### Induction Furnace Leads

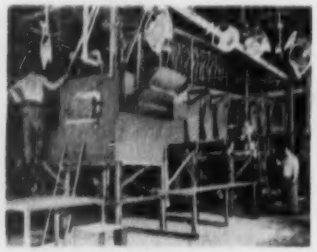
New high frequency water-cooled lead design is said to reduce furnace

cost, cut power losses, increase lead life, facilitate connection, permit better coil design and smaller and more rigid furnace shell, and eliminate damage to leads if the lining should fail. *Inductotherm Corp.*

CIRCLE No. 30, PAGE 83-84

### Automatic Aluminum Melting

Automatic, continuous, in-line melting of aluminum alloys makes use of a new type radiant gas-fired tunnel furnace. Immediate advantages claimed are: flexible production, quick



heat-up, and reduced fuel costs, better working conditions, and greater control of quality. *Monarch Aluminum Mfg. Co.*

CIRCLE No. 31, PAGE 83-84

### Infrared Radiation Pyrometer

Servotherm Infrared Radiation Pyrometer IR-1 covers a nominal temperature range of ambient to 1832 F

and indicates variations as small as 0.1 F and even smaller when operated by an experienced technician. Bulletin says response time is 25 milliseconds. Although it has its own meter, output may be fed to a recorder for more permanent records. *Servo Corp.*

CIRCLE No. 32, PAGE 83-84

### Semi-Automatic Grinder

Lewis No. 1 Billet Surface Conditioning Grinder gave up to six times as much production as conventional swing grinder, might find application in production foundries making medium-size and large castings. Billets are mechanically handled, operator works seated in pulpit protected with safety glass. *Lewis Machinery Div., Blaw-Knox Co.*

CIRCLE No. 33, PAGE 83-84

### Ball Point Marking Tube

Fast-drying, permanent marking ink in an improved, handy package applicator will not readily chip, peel or be affected by heat or weathering. Burst-proof tube is fitted with a smooth act-

ing ball point. Good for castings, wood, and plastics. Different size ball points and seven colors are available. *John P. Nissen, Jr. Co.*

CIRCLE No. 34, PAGE 83-84

### Single Column Fork Truck

Lift truck operators can see better, work faster, and work safer with the new Hyster Monomast with panoramic visibility (models YC-40 and UC-30). Single column construction of two box-shaped sections, one telescoping within the other, provides strength, rigidity, and almost eliminates obstruction of operator's vision. *Hyster Co.*

CIRCLE No. 35, PAGE 83-84

### Ultraviolet Light Inspection

Sela Ultra Violet Unit Model LR is used in the detection of flaws and cracks in castings, pin-holes and leaks in containers. The specimen is immersed in a solution such as anthracene, and tested under ultra violet light after washing off the excess. Fissures deeper than superficial cracks are clearly revealed by this simple test. *Sela Electronics Co.*

CIRCLE No. 36, PAGE 83-84

### Wing Dividers

Fine settings and accuracy are claimed in two new wing dividers recently made available. One of the dividers, No. 57, has two solid legs for scribing circles or arcs on hard or rough surfaces. The other, No. 58, functions as a divider or compass by virtue of a leg which is replaceable by a pencil. Settings are secured by a full-thread engagement of clamping nut. Hairline-fine adjustment is made by a tension spring working in conjunction with a locked-on adjusting nut. Each model comes in six and eight in. sizes. *Stanley Works.*

CIRCLE No. 37, PAGE 83-84

### Super Masonry Saw

Clipper Super Model masonry saw is designed for low-cost production cutting of every refractory and masonry material. Heavy-duty blade shafts and oversize bearings; available in 14 and 18 in. blade capacities, wet-and-dry cutting or dry cutting only with conversion to wet-and-dry later. Converts to concrete saw or track saw. *Clipper Mfg. Co.*

CIRCLE No. 38, PAGE 83-84

### Pneumatic Vise

Model 666, Vi-Speed Autovise is designed as an air clamp on cut-off saws

## Increase Metal Handling Efficiency

**Here's How Allis-Chalmers Mfg. Co. substantially increased foundry production at the LaCrosse (Wis.) Works by using a Whiting Trambeam overhead conveyor system combining individual cranes for pouring in each of 27 production areas with monorail transport of hot metal to the areas. In addition to mechanizing hot metal hanlding, the following benefits have been derived: more efficient use of floor space—molds can be stacked higher, dust reduction from reduced floor traffic, and improved employee morale and productivity. Metal is now poured directly into transfer ladles, eliminating a reservoir ladle and allowing as much as 40,000 lb of metal to be poured in 2 hr and 20 min, compared with a maximum of 25,000 lb previously. A Trambeam cupola charging crane with cone-bottomed charging bucket reduced the cycle for a 2000-lb charge to 4½ min.**

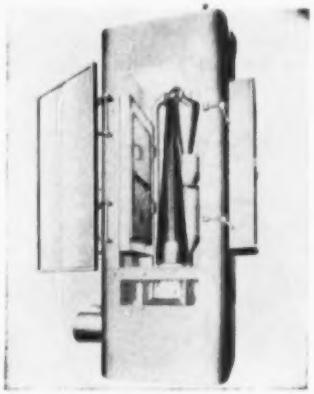
CIRCLE No. 39, PAGE 83-84

and is ideal for holding castings for cleaning room operations. Jaw faces are removable, and can be drilled and tapped for attaching fixtures and dies. The 6x6-in. jaws open to 8-in. max; the massive 5 in. OD push rod, with 6-in. stroke develops 1900 lb gripping force at 100 psi line pressure. Information on trial units and literature are available on request. *Van Products Co.*

CIRCLE No. 40, PAGE 83-84

**Packaged Dust Collector**

"Packaged", Type G.W.F. Aerodyne collector is complete within itself with Aerodyne Louvered Cone and one or more fiber filter packs in series. Capacities range from 1000 to 10,000 cfm free air, taking motors from 1½

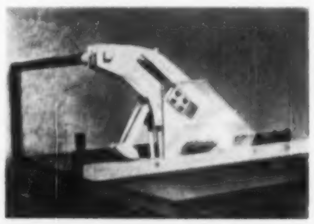


and 15 hp in sizes of 3 x 3 x 7-ft to 5½ x 5½ x 14-ft. Claim, for all practical purposes, all solids and most condensable fumes are removed. Literature available. *Green Fuel Economizer Co.*

CIRCLE No. 41, PAGE 83-84

**Transparent Circular Saw Guard**

New gliding-action guard lets user all table model circular saw work operations clearly through transparent plastic shields. Protects during cutoff, ripping, dado, and grooving work to various widths and thicknesses; not



necessary to remove guard and risk injury. For extra safety, unit has large and strong dual "anti-kick backs." *General Scientific Equip. Co.*

CIRCLE No. 42, PAGE 83-84

**Air Control Valves**

Model 6668 solenoid bleeder, air cylinder-actuated, 2- or 3-way valve is used for electric push-button, limit switch, timer, etc., bleeder and pilot-operated master valves. 115- or 230-volt, 50- or 60-cycle, AC continuous duty standard; special duty features are available. Model 6669 dual-control 2-way valve provides automatic reversal when current is shut off. Model 6678 4-way, 2-position valve is designed for operating double-acting air cylinders. Catalog 100-4 available. *Logansport Machine Co.*

CIRCLE No. 43, PAGE 83-84

**Oil-Less Air Compressor**

New, piston-type air compressor is said to deliver oil-free air at 35, 75, and 175 psi with continuous operation and make practical individual motor driven compressors mounted where com-

pressed air is needed. Claims portability and comparatively low cost make it adaptable to all types of industrial maintenance. Bulletin 1254 available. *Bell & Gossett Co.*

CIRCLE No. 44, PAGE 83-84

**Tube Axial Exhaust Fan**

Propellair Tubeaxial Fans are a new line of belt-driven tubeaxial propeller fans designed for handling corrosive exhaust, high temperature, explosive fumes, and similar difficult air-moving applications. Available in five sizes from 16 through 36-in., the new fans have air delivery ratings to 26,000 cfm. *Robbins Myers, Inc.*

CIRCLE No. 45, PAGE 83-84

**Metal Cutting Saw**

A metal cutting saw that operates as a band saw or a cut-off saw is known as Gibbes-Kennedy. It saws contours and performs cut-off operations. Table mounted, it is easily detached for portable cut-off use. Weighs only 365 lb complete with table. Powered by 1/3 or ½hp—115 volt motor. It has three cutting speeds. Additional literature is available. *Gibbes Machinery Co.*

CIRCLE No. 46, PAGE 83-84

# talk of the industry

FOOLPROOF SAND has been a goal of the foundryman ever since he discovered it is safe to pour molten metal into a green sand mold. One school of thought is based on a 4-screen (the AFS Grading, Fineness & Distribution Committee should excuse the expression) sand. Newest discovery indicates that you have a minimum of headaches due to sand when total surface area of the sand grains equals total surface area of the clay particles. Whether grain distribution is 4-screen or not seems to make no difference if you stick with the proper surface area relationship, according to this new development.

PROFIT SHARING THOUGHTS that established the theme for last month's Bonus Section( Controlling Costs in the Foundry) were photographed in the plant of Pangborn Corp., Hagerstown, Md., where employees are reminded: Jobs depend on sales . . . Sales depend on price . . . Price depends on cost . . . Cost depends on you. While employees are doing their best to hold the cost line, management develops as realistic a cost picture as possible and fomulates policies on what to do about it. Preferred way to keep costs under control is detailed in the September Bonus Section of MODERN CASTINGS.

PEARLITIC MALLEABLE IRON production in 1955 will approach 170,000 tons, about double 1954, according to Lowell D. Ryan, managing director of the Malleable Founders' Society. While including MFS member companies only, the figure is believed to represent up to 95% of the total made in the United States. 1955 is expected to be the second best year for malleable production. Previous high was 1,080,000 tons in 1951 and current indications are that this may be equalled though not exceeded to any great extent. High rate of both pearlitic and standard malleable production is attributed to high automobile and truck output, upturn in agricultural implement building, and sharp increase in demand for railroad malleable. Other lines have come up greatly since the latter part of 1954.

WHAT STARTED OUT to be a scholarship fund has become a memorial to the late Bob Kennedy, long-time secretary of the American Foundrymen's Society. Set up in 1954 when the Chicago Chapter established the Robert E. Kennedy Scholarship with $5000, the money provides financial assistance for interested University of Illinois (Navy Pier) students of good scholastic standing and foundry inclination. On Bob's death August 7, the Chicago Chapter board of directors placed an additional sum of $500 in the scholarship fund to help build up this functional memorial to the man who served AFS so long. Contributions are also being received from individuals and companies. Those wishing to honor the late secretary emeritus should make checks payable to: Chicago Chapter of the American Foundrymen's Society. They may be sent to Louis J. Jacobs, Treasurer, AFS Chicago Chapter, S. Obermayer Co., 2563 W. 18th St., Chicago 8, Ill., or to the AFS Technical Center, Golf & Wolf Roads, Des Plaines, Ill.

DO IT YOURSELF on "hobby day" if you have a good attendance record. That's the set-up at Light Metals Corp. where absenteeism and tardiness are kept in check by a unique system of hobby days. A hobby day

# pouring off the heat

## they're not ignoring us!

▪ It is true the bigger page of Modern Castings gives more visibility but when it is folded into three sections the pages are hard to turn and read. In addition it is too large to file.

A. W. Bardeen, *Tech. Dir.*
Ohio Brass Co.
Mansfield, Ohio

▪ How can anyone file it or stack it? Contents are great. We always look forward to the next issue and will continue to do so in spite of the size. We will buy an easel to hold it while reading.

James Barr, *Gen. Mgr.*
Compton Foundry
Compton, Calif.

▪ Like trying to manage two handsful of wet fish.

Carl B. Johnson, *Slsmn.*
Queen City Sand & Supply Co.
Buffalo, N.Y.

▪ Have the readers lost title to "The Foundrymen's OWN Magazine" which is now "OWNED by the Men Who Buy"?

A. E. Cartwright, *Met.*
Crane Limited
Montreal, Que.

▪ I surely like the contents of the magazine but thoroughly despise the shape of the pages.

J. Thompson, *Chf. Wks. Eng.*
Continental Fdry. & Machine
East Chicago, Ind.

▪ It does not fit into a file drawer or a bookcase. When it is piled, the type of binding prohibits identification from the back. The new size is not particularly adaptable to removal of articles for my technical file. I find it difficult to sit back and read through the magazine without considerable fumbling.

On the other side of the ledger, I think the Bonus Sections are excellent. I like "Talk of the Industry." The technical material throughout is good.

I think we have the best magazine in the business except for the unfortunate proportion.

F. B. Rote, *Tech. Dir.*
Albion Malleable Iron Co.
Albion, Mich.

▪ Change in title and content is all to the good, but I must raise a dissenting voice about the size. It's just too big and I have no idea what our librarian is going to do about binding it.

D. L. La Velle, *Asst. Mgr.*
Aluminum Dept.
Federated Metals Div.
American Smelting & Refining Co.

▪ Content of the magazine—OK. Bigger page—definitely do not like.

Allen M. Slichter, *Pres.*
Pelton Steel Casting Co.
Milwaukee

▪ Bibliographically speaking, you are making a horrible dent in Anglo-American relations and I don't believe American librarians will love you either.

Daphne Drake, *Tech. Lib.*
British Cast Iron Research Association
Birmingham, England

▪ I find the old size more to my liking. It was easier to read, handle, and file. The only people that prefer the new style are the advertisers. On the other hand, the Bonus Section is a fine feature. The increased content is appreciated and as a whole I believe some subscribers are too critical.

Chet Mack, *Foreman*
Chautauqua Hardware Corporation
Jamestown, N.Y.

▪ MAY I BE AMONG THE FIRST TO CONGRATULATE THE STAFF OF MODERN CASTINGS ON YOUR NEW DRESS. COMPOSITION AND MAKEUP ARE EXCELLENT. HEARTIEST CONGRATULATIONS TO EVERYONE FOR WHAT I KNOW WILL NOW BE A VERY SUCCESSFUL ENTERPRISE.

Bruce L. Simpson, *Pres.*
National Engineering Co.
Chicago

▪ Modern Castings—what the dickens have they done with our American Foundryman was my first reaction. "Thumbing" seems to fit the description of my interest now.

Yes, definitely the new format is more appealing, the articles are grouped better, and even more in-

(written into the union contract) is half a working day--"four continuous hours off with pay at straight-time base pay rates"--awarded to eligible employees every 13-week work period. To be eligible an employee (1) must report to work and work every day he or she is scheduled to work for 13 consecutive pay periods and (2) must not be late to work more than three times during the 13-week period. There are exceptions for such reasonable cause as "proven sickness or injury or previously authorized leave of absence or permission to be late for work.

SALES AND NET PROFIT survey of the Investment Casting Institute shows that sales are up but profit averages are below those of competing industries. Average 1954 sales for the companies reporting was $957,953. These companies predict investment castings sales for 1955 will be up 60.7% over 1954. Total 1955 volume is expected to reach $125,000,000. Rise in sales is the result of accelerated procurement of jet engine components, according to ICI President Ted Operhall, president of Misco Precision Casting Co., who reports that design latitude of investment castings is opening other markets and customers.

METALLURGICAL STRAWS IN THE WIND . . Last month we reported use of a fibrous binder for carbon semi-permanent molds. This month our "fiber" comments are based on an entirely new technique--fiber metallurgy--developed at Armour Research Foundation. Operations are similar to powder metallurgy but starting material is short metal fibers. Products having a wide range of porosities with relatively high strength and toughness are expected to be produced. In production, the metal fibers (suspended in a liquid) are felted or matted by pouring the suspension over a suction filter. After drying, the interlocked fibers can be sintered, coined, impregnated, pressed, or (along with lower melting brazing material) heat treated to improve strength and ductility. Don't know what it's good for in the castings industry (blow box vents maybe) or how it might compete with castings as structural components at this stage.

OPERATIONAL PROFILES of five efficiently run United States gray iron foundries with employment ranging from 20 to 151 are contained in a report recently issued by the Bureau of Labor Statistics. Covered in nearly 200 pages are manufacturing techniques, plant layout, products, equipment, man-hour requirements by departments and operations, and functions of management in coordinating activities. Also included are plant staffing, labor-management relations, employment characteristics, capital ratios, costs, and selling methods. Gray iron foundrymen who recall manpower problems of World War II and attitudes toward gray iron will appreciate this statement in the introduction: "Because of its versatility and unique engineering properties, gray iron castings form the basic and essential components of practically all production equipment. These castings have important uses in virtually all major industries--agriculture, machine tools, railroads, mining, mechanical power transmission, food processing, and automotive." Copies of BLS Report No. 85, "Case Study Data on Productivity and Factory Performance--Five Small Gray Iron Foundries," are available at no cost from the nearest Department of Labor office or from Bureau of Labor Statistics, U. S. Department of Labor, Washington 25, D.C.

IT'S HARD ENOUGH to pick a good site for a new foundry what with markets, labor force availability, raw material sources, air and stream pollution, taxes, and a host of other considerations. But it's more difficult than ever today, especially if you're producing critical aircraft castings. Foundry soon to be built has to be located a good piece south of the nearest industrial atomic bomb targets because prevailing winds are from the south. Object: to avoid radioactive fallout.

Herbert F. Scobie

teresting. You've given us somewhat of a jolt, but believe there is at least 50 per cent improvement. Congratulations!

ROBERT B. MCKINLEY, *Owner*
McKinley Metal
Fort Worth, Texas

▪ The "new look" is very good. Best magazine on the market. Keep up the pace on good and interesting articles.

MAURICE T. DEGLEY
Ferro Engineering Co.
Cleveland

▪ I like it. It's different, articles are concise and to the point. Advertisements never before noticed are now being read. "Products & Processes" occupies the pronounced spot it should because this section interests everyone.

EARL M. STRICK, *Fin. Supt.*
Erie Malleable Iron Co.
Erie, Pa.

▪ I feel the size is awkward but certainly that is only a minor consideration. The contents, well written, cover a broad field, and I am sure additional advertising will be helpful in publishing a better magazine and will provide more operating income for our organization. I have talked with a number of persons in the Twin City Chapter and think the majority feel, as I do, that it is a better magazine than the old one.

J. W. COSTELLO, *Patt. Supv.*
American Hoist & Derrick
St. Paul, Minn.

▪ I believe the bigger page would give more visibility if we received the magazine unfolded. How about sending it flat like *Fortune?*

K. A. DE LONGE, *Met.*
International Nickel Co.
New York

*MODERN CASTINGS is being mailed flat in envelopes beginning with this issue. We're sorry it hasn't been reaching all of you in the best shape.*

*The response to MODERN CASTINGS and its new format is tremendous and runs from bouquets to brickbats. Even when readers object the editors have been greatly pleased with the proprietary inter-*

*continued on page 57*

# for the asking

### Core and Mold Washes

Grakoat core and mold wash for gray iron, malleable, and non-ferrous applications and Steelkoat for steel are said to be easy to apply, moisture proof, not easily precipitated, nongaseous, highly refractory, and deep penetrating in bulletin from *Delta Oil Products Co.*

CIRCLE No. 47, PAGE 83-84

### Direct Arc Furnaces

64-page Catalog 9-A tells the story behind Lectomelt furnaces, gives special information on gray and malleable iron production, shows numerous installations, and lists specifications for furnaces handling 20 lb to those with 150 ton capacities. *Pittsburgh Lectromelt Furnace Corp.*

CIRCLE No. 48, PAGE 83-84

### Pattern Shop Machinery

The Oliver line of woodworking machinery for pattern shops covered in 8-page folder includes disc and spindle sanders, circular and band saws, lathes, surfacers, milling machines, embossing presses, benches, vises, and tool grinders. *Oliver Machinery Co.*

CIRCLE No. 49, PAGE 83-84

### Planned Mechanization

18-page bulletin on planned mechanization for foundries with progressive and complete systems features Neway foundry equipment. Included are Reddy Sandies, Handy Sandies, aerators, plate feeders, turntables, core crushers, mill, sand gates, and conveyor and elevator take-ups. *Newaygo Engineering Co.*

CIRCLE No. 50, PAGE 83-84

### Pan-type Vibrating Conveyors

Simplicity Series 32 balanced pan-type conveyor requires only a minimum of supporting structure and may be suspended from a main frame support with spring and cable connections. Bulletin 3255 also shows three drives that are used with Series 32 balanced and conventional conveyors. *Simplicity Engineering Co.*

CIRCLE No. 51, PAGE 83-84

### Monomast Lift Truck

New lift truck with single lifting column is claimed to offer greater visibility, result in faster, safer work-output


with less driver fatigue. Box-type upright is said to be stronger, more stable than conventional assemblies. Catalog Form 1402 available. *Hyster Co.*

CIRCLE No. 52, PAGE 83-84

### Core Blowers

Besides giving tips on core box equipment, blow and vent holes, and preventive maintenance, Bulletin 5000 describes the complete line of Champion core blowers with illustrations of machine and application, engineering drawings, and specifications. One feature of every machine is allowance of frame for side-to-side and front-to-back coremaker operations. *Beardsley & Piper Div., Pettibone Mulliken Corp.*

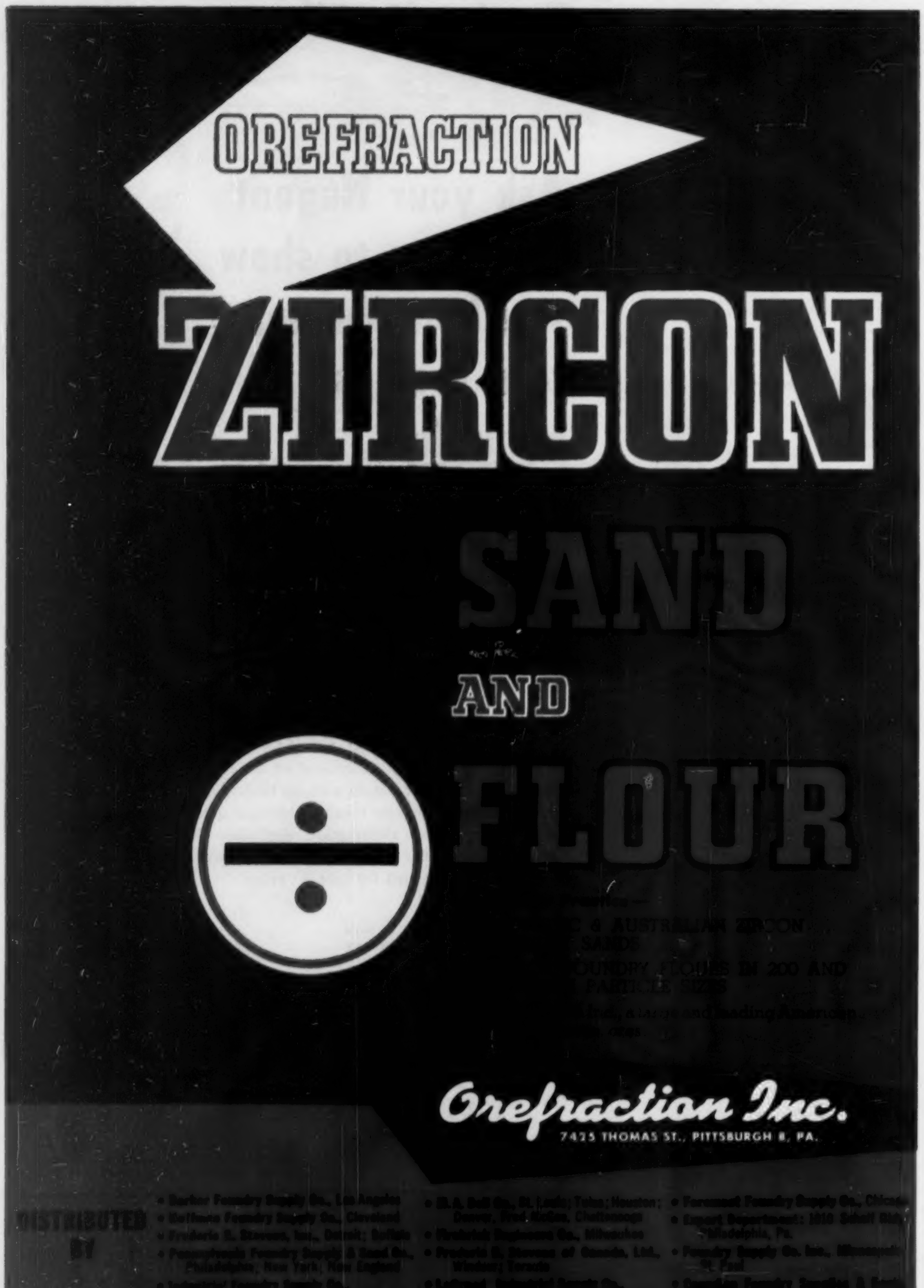
CIRCLE No. 53, PAGE 83-84

### Molding Machine

Special features of line of type BT jolt, squeeze, turnover, and pattern draw molding machine include jolt timer, press button operation, streamlined for easy cleaning, automatic lubrication, automatic pneumatic anvil, built-in air filters, easy mold removal, simple operation. 34-page booklet AB/658 includes specifications and in-



CIRCLE No. 78, PAGE 83-84




structions. *British Molding Machine Co., Ltd.*

Circle No. 54, page 83-84

**Riser and Strainer Cores**

The Louthan line of refractory core shapes illustrated and described in recent folder claims these advantages: to save labor, material, equipment, space, time required in molding, baking, inspecting, and handling sand cores; will withstand considerable rough handling, come packaged for easy storage and handling, and insure cleaner sounder castings. *Louthan Mfg. Co.*

Circle No. 55, page 83-84

**Foundry Equipment**

Complete line of Link-Belt equipment is covered in 40-page Book 2423. Seven foundry layouts of different type and capacity are given. Included are sand dryers and coolers, mullers and mixers, revivifiers, screens, belt, oscillating, apron, and overhead conveyors, table and belt feeders, shakeouts, and bucket elevators. *Link-Belt Co.*

Circle No. 56, page 83-84

**Sand Stabilizer**

Lin-O-Cel is a sand additive. Bulletin 8170 says that Lin-O-Cel is a finely ground cellulose material which, when mixed with foundry sands, provides an easy, efficient, and economical means of preventing such casting defects as rat-tails, buckles, and scabs. *Archer-Daniels-Midland Co.*

Circle No. 57, page 83-84

**Cleaning Shell Castings**

Seven advantages of Wheelabrator blast cleaning are listed in recent issue of Cleaning and Finishing News bulletin. Application in three foundries making shell molded castings are illustrated, and casting size, load, and blast time are tabulated. *Wheelabrator Corp.*

Circle No. 58, page 83-84

**New Grinding Wheel Catalog**

29-page catalog 1-55 lists stock abrasive items and includes list and net prices. Covered are standard wheel marking, specifications, bonds and abrasives, recommended safe wheel speeds, wheel shapes, general purpose, cut-off, and snagging grinding plus mountd wheels shapes, and points. *Sterling Grinding Wheel Co.*

Circle No. 59, page 83-84

**"Precious Metal" Lead**

"The Story of National Lead Company" is a 36-page, illustrated, color

 Circle No. 79, page 83-84

booklet that treats their story with the following topics: die casting, oil business, titanium, bearing metals, battery metals to blatchford base, and Kirksite. *National Lead Co.*

CIRCLE No. 60, PAGE 83-84

**Core Binder**

Technical Bulletin F-7 describes Foundrez 7991 as a dual-purpose core binder which unites in one product the desirable green working properties of conventional core oils with the desirable casting properties of water-soluble phenolic resins. Composition, characteristics, advantages, and methods of use are covered. *Reichhold Chemicals, Inc.*

CIRCLE No. 61, PAGE 83-84

**Employee Relations Service**

New brochure describes how personnel and labor relations are approached by counseling service. In many instances a large part of an assignment can be carried out by the plant management under guidance of a consultant. *National Foremen's Institute.*

CIRCLE No. 62, PAGE 83-84

**Casting Sealer Unit**

Illustrated in bulletin is a typical controlled-temperature reservoir and pump unit for Porlox Seal, a new metal oxide-type sealing material that is claimed to impregnate all types of castings against microscopic porosity. *Prenco Products, Inc.*

CIRCLE No. 63, PAGE 83-84

**Vertical Storage**

Super-Concrete Stave Storage Bins are featured in bulletin that describes the material, construction, and capacities of this type of vertical storage. Firm states that their background in materials handling allows them to aid in the selection and location of handling machinery. *Neff & Fry Co.*

CIRCLE No. 64, PAGE 83-84

**Dust Collector Analysis**

"An Analysis of an Installation of Dust Collecting Equipment," describes a scientific analysis of Schneible Multi-Wash Dust Collectors under actual production load made by an outside laboratory. *Claude B. Schneible Co.*

CIRCLE No. 65, PAGE 83-84

**3-part Utility Folder**

New, 3-part utility folder is a wall chart reminder of metal finishing supplies and equipment and is a stock

record for checking inventories. It also contains an emergency first aid chart for treatment of plating room accidents and can be used as file folder for technical bulletins and sales literature. *Fredric B. Stevens, Inc.*

CIRCLE No. 66, PAGE 83-84

**Foille Burn Kit**

Bulletin 0402-3 points out advantages of the aerosol spray technique for quick application of Foille antiseptic. In addition to controlling pain, mitigating shock, and helping to preserve tissue in burned areas, bulletin says detergent action often eliminates scrubbing grease-stained, dirty wounds. *Mine Safety Appliances Co.*

CIRCLE No. 67, PAGE 83-84

**Bibliography on Cast Steel**

444 references are listed in new, 28-page "Bibliography on Cast Steel." 400 are from literature of the last 20 years. Most are from American publications, some from British, a few from other language publications. *American Foundrymen's Society.*

CIRCLE No. 68, PAGE 83-84

**3-D Scale Models**

Applications of three-dimensional scale models as well as some of the features of Knight-built models are outlined in eight-page bulletin. Magnetized models made for flexible trial layouts. Applications include plant design, layout and production, employee training, architecture and construction planning, and site development. *Knight Models, Inc.*

CIRCLE No. 69, PAGE 83-84

**Who's Who in the Castings Field**

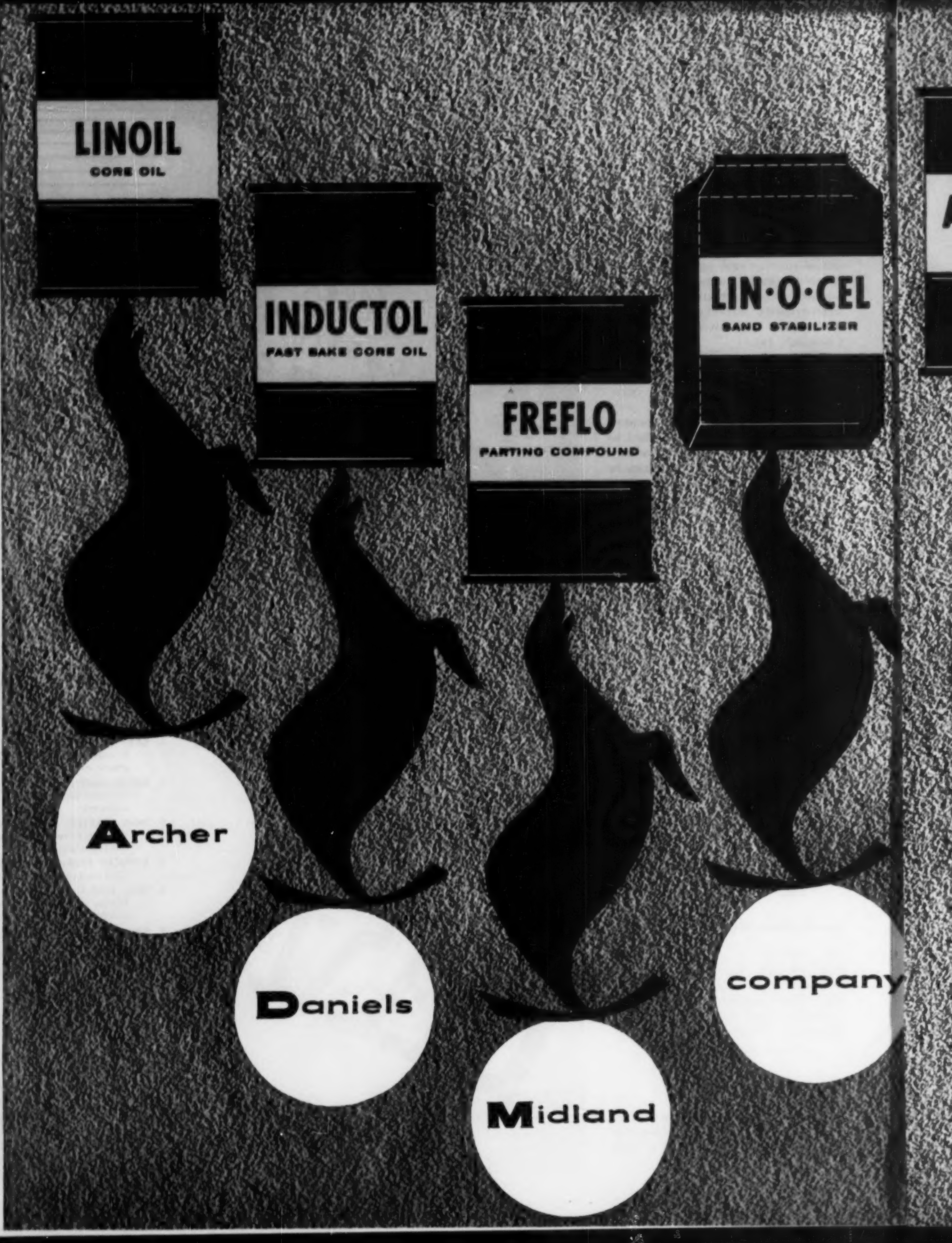
Eighty-seven leaders of foundry thought and technique who recognize that advancement of the industry relies on exchange of knowledge with articles in *Modern Castings and American Foundryman* are recognized in this brochure. Photographs of 63 are included. In addition short biographies of the magazine's editors and associates are given. *American Foundrymen's Society.*

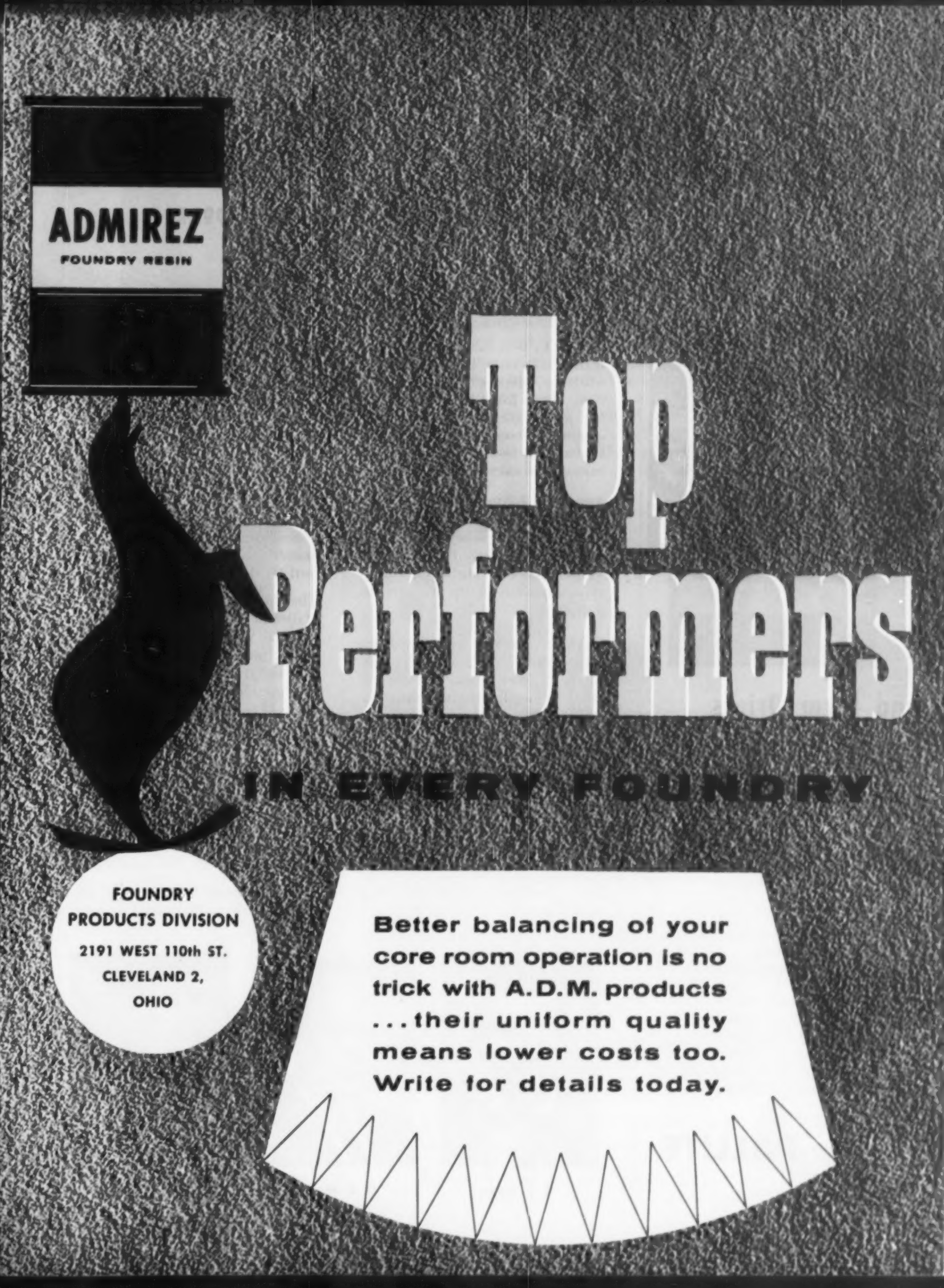
CIRCLE No. 70, PAGE 83-84

**Use of Southern Bentonite**

Producer of both southern and western bentonite, tells about the application of southern bentonite to gray iron, malleable, steel, and nonferrous practice in 14-page Bulletin 243, Economy in the Foundry. Special reference is made to tempering. *American Colloid Co.*

CIRCLE No. 71, PAGE 83-84






**Floor Maintenance**

Bulletin 1219C discusses uses for Carbo-Tread in resurfacing and repair of floors. Reported to take traffic as soon as it is applied. *Maintenance, Inc.*

CIRCLE No. 72, PAGE 83-84

**Machine Rehabilitation**

Scientific methods of machinery inspection and new methods of industrial equipment repair are covered in Bulletin 55. Claim most services are performed on location saving dismantling and moving costs. *Maintenance Engineering Corp.*

CIRCLE No. 73, PAGE 83-84

**Gamma Radiography**

12-page booklet presents basic information required for setting up or operating a gamma-radiography installation; tells how to select the proper radioisotope for handling equipment, and discusses the principles of radiation safety. Tables and charts show characteristics, radiographic sensitivity, and isotope speeds. *Technical Operations, Inc.*

CIRCLE No. 74, PAGE 83-84

**Electric Lift Trucks**

Three bulletins describe specifications and aspects for efficient operation of the new Yale K-46 electric, stand-up, hydraulic lift truck. These models (2, 3, and 4000 lb capacity) are available in 68, 83, and 90 in. overall heights with teloscopic lifts up to 100, 130, and 144 in. respectively. *Yale & Towne Mfg. Co.*

CIRCLE No. 75, PAGE 83-84

**Combustion Safe-Guards**

Bulletin 2101 describes the application of Honeywell temperature controls, limit controls, valves, and Protectoglo combustion safeguard systems to Maxon Premix Industrial Gas Burners and burner systems. Schematic system diagrams and selection tables are included. *Minneapolis-Honeywell Regulator Co.*

CIRCLE No. 76, PAGE 83-84

**Fuel Oil Treatment**

Bulletin describes Dacarol as an oil soluble fuel oil additive which eliminates sludge, frees system of deposits, improves atomization, improves Btu release, and disperses water. *Dacar Chemical Products Co.*

CIRCLE No. 77, PAGE 83-84

CIRCLE No. 81, PAGE 83-84

## You Who Weld Castings

We'll all know much more about cast iron welding if each of us tells the Joint Committee on Welding Iron Castings what we have found out about the process.

Manufacturers of welding rod as well as users are invited to submit data or test reports on the mechanical properties of gray iron weldments to this joint committee of the American Welding Society and the American Foundrymen's Society.

Also welcomed by Sidney Low, Chapman Valve Mfg. Co., Indian Orchard, Mass., chairman of the Mechanical Properties of Weldments Subcommittee, are any other data on welding iron castings such as test methods, metallography, different filler metals, etc.

If desired, source of information will be held in confidence.



# let's get personal

**George C. Betz** has been appointed manager of sales, Chemical & Metals Dept., Metal & Thermite Corp., New York. **John A. Peterson, Jr.,** has joined the company's ceramic engineering staff, and **William C. Cuntz** has been named assistant manager of sales, Welding Dept.

**James A. Johnson** has been promoted to the newly created position of general superintendent of the Indiana Steel Products Co., Valparaiso, Ind. He was formerly superintendent of the foundry department.

**David C. McVey** has joined the Chicago office of Climax Molybdenum Co., New York. He was formerly a metallurgist with International Harvester Co.

**Ralph G. Mensch** has been appointed district sales manager for specialty resins at the Argo, Ill., plant of Reichold Chemicals, Inc., New York.

**Clare B. Carlson** has been named manager of the Electrothermic Div., Pittsburgh Lectromelt Furnace Corp.

**Robert H. Jacoby,** formerly chief metallurgist and manager of quality control of Key Co., East St. Louis, Ill., has become an associate of the St. Louis Coke & Foundry Supply Co., St. Louis.

**J. A. Dean** has been promoted to manufacturing manager of Nelson Electric Mfg. Co., Tulsa, Okla. He was formerly manager of the foundry division of the firm. **E. F. Hines,** foundry sales manager, will succeed Mr. Dean as foundry manager.

The board of directors of Badger Malleable & Mfg., Co., South Milwaukee, Wis., has elected the following officers: **T. E. Ward,** president and treasurer; **W. J. MacNeill,** vice president in charge of operations; **Leo Joerg,** secretary, and **August Schwan,** assistant treasurer.

**Maurry R. Petersen** has been appointed sales engineer in the Ohio territory for the George Sall Metals Co., Philadelphia.

**Raymond F. Stevens** has joined Acheson Colloids Co., Port Huron, Mich., as research chemist.

**F. Paul Ronca,** manager of the Silicon Carbide Products Engineer-

E. F. Hines

D. C. McVey

J. A. Dean

ing Dept., Carborundum Co., Niagara Falls, N. Y., was elected chairman of the Technical Committee of the Abrasive Grain Association.

C. B. Carlson

**C. Taylor Marshall** has been promoted to general manager of the newly consolidated Coke and Iron Div., Pittsburgh Coke & Chemical Co.

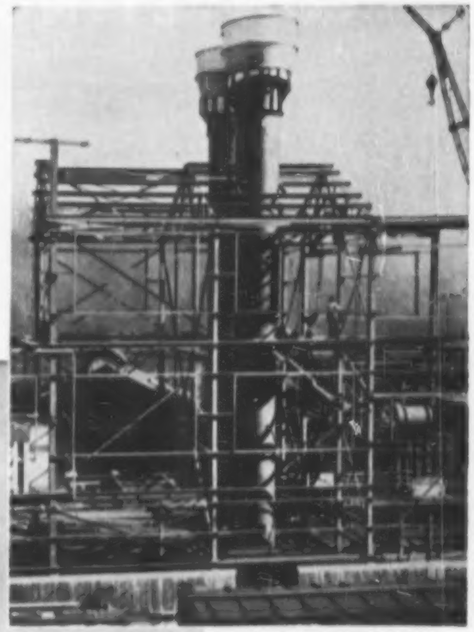
R. H. Jacoby

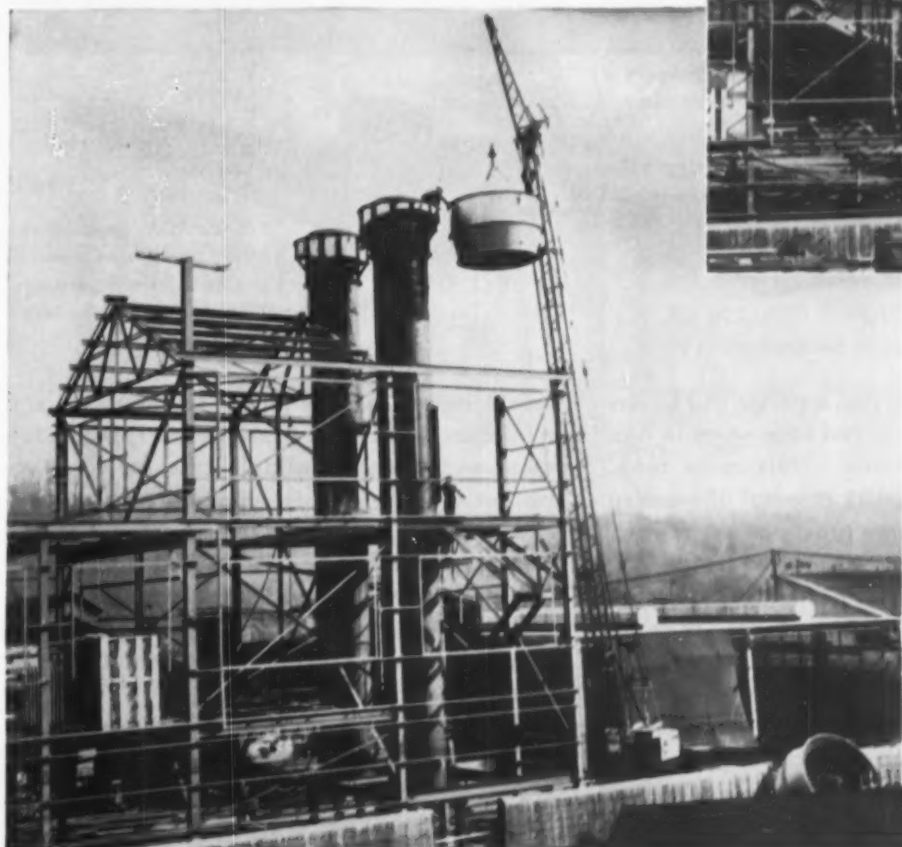
**Clinton F. Zabriskie**, foundry metallurgist, Sperry Gyroscope Co., has been appointed metallurgist, materials and processes, for the firm.

R. G. Mensch

**A. M. Kohler**, vice-president of the Babcock & Wilcox Co., New York, and head of its Refractories Div., has retired from the company. Ac-







tive charge of the Refractories Div. has become the responsibility of **J. E. Brinckerhoff** as manager.

**A. S. Breighthaupt**

**Arthur S. Breighthaupt,** vice-president and sales manager, Dodge Steel Co., Philadelphia, has been named vice-president with responsibilities extending into the field of operations. He will also continue in his present capacity.

**Arthur J. Zwanzig** has been appointed assistant to the vice-president and general manager of Alloy Precision Castings Co., Cleveland. He will direct all production activities.

**Arthur B. Morse** has been appointed vice-president and western sales manager for the Mexico Refractories Co., Mexico, Mo.

**A. B. Morse**

**R. E. Rogers,** formerly manager of the Los Angeles branch of the Foxboro Co., Foxboro, Mass., has been appointed manger of the instrument company's west coast sales activities.

**Dr. David W. Levinson** has been appointed supervisor of non-ferrous metallurgy research in the



Circle No. 84, page 83-84

Metals Research Dept., at Armour Research Foundation of Illinois Institute of Technology, Chicago.

**Claude A. Marlowe** has been elected executive vice-president of the Pittsburgh Metals Purifying Co.

**Stanley J. Wozniak** has been appointed assistant foundry superintendent of the Hansell-Elcock Co. Foundry, Chicago.

G. C. Cole

**Grover C. Cole** was elected vice-president of Wysong & Miles Foundry, Inc., Greensboro, N. C., at the annual meeting of the stockholders and directors.

**George T. Morse** has been appointed vice-president and director of sales for the Smooth-On Mfg. Co., Jersey City, N. J.

**Donald E. Wyman** has been appointed sales manager covering all products of Exomet, Inc., Conneaut, Ohio.

**Donald N. Watkins** has resigned as vice-president of Continental Foundry & Machine Co., Pittsburgh, Pa., to devote his time to his position as chairman of Steel Publications.

**Thomas Trowbridge** was named assistant general sales manager of the Behr-Manning Div., Norton Co. **William J. Bennett** became sales manager for the company's eastern region and **Victor F. Perrault** was appointed industrial trades manager.

Norton Co., Worcester, Mass., has appointed **Gale W. Bennett** a refractories engineer. Bennett succeeds **Norman K. Russell** who resigned from Norton to become

sales manager for the Richard C. Remmey & Sons Co., Philadelphia.

**Fred J. Walls,** metallurgical engineer, International Nickel Co., Inc., in charge of Detroit technical section of the Development and Research Div., has been elected treasurer of the Engineering Society of Detroit.

**Karl-Erik Bäckström,** metallurgist and foundry superintendent, Lidköpings Mekaniska Verkstads Ab, Lidköpings, Sweden, is becoming acquainted with American jobbing practice in gray iron and nodular iron by working this summer at Beloit Foundry Co., Beloit, Wis. In addition, he is visiting foundries in the Milwaukee, Chicago, Cincinnati, New York, and Philadelphia areas.

**Herbert E. Eggerts** has joined Kingwell Bros., Ltd., San Francisco, and will be in charge of foundry operations. Among his responsibilities will be the installation of Kingwell's new non-ferrous foundry to be built at Richmond, Calif., and in operation early in 1956.

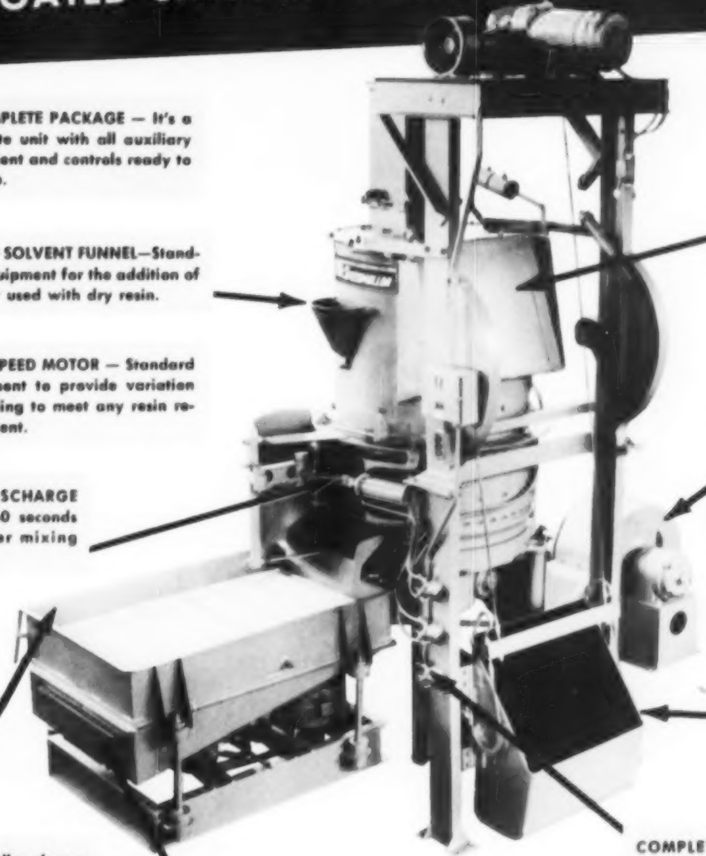
H. E. Eggerts

**William V. Burley, Jr.,** has been appointed comptroller of Titanium Metals Corp. of America, New York. The company is jointly owned by National Lead Co., and Allegheny Ludlum Steel Corp.

**Dr. Donald J. McPherson** has been promoted to assistant manager of the Metals Research Department at Armour Research Foundation of Illinois Institute of Technology, Chicago. **J. Scott Griffith** has been promoted from supervisor to assistant manager of the ceramics and minerals research department.

*continued on page 29*

# COLD PROCESS, FREE-FLOWING, NON-CLUMPING, RESIN-COATED SAND IN 5 MINUTES INSTEAD OF 25




## NEW CP SHELL SPEEDMULLOR SLASHES COSTS FOR SHELL MOLDERS

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For the first time the operator has full control over all of the variables of cold process preparation. Three position mullor wheel spacing and two speed mullor motor provide a wide range of variation of mulling pressure.

In addition, the volume of air blown *through* the sand mass (only the Shell Speedmullor provides this feature) may be varied from zero to maximum to meet requirements. These new units handle either liquid resin additions or solvent and dry resin additions. Mulltrolmatic — the ultimate of automatic control — is available to control every phase of the operation.

For full information and prices write directly to *BEARDSLEY & PIPER, Division Pettibone Mulliken Corporation, 2424 North Cicero Avenue, Chicago 39, Illinois.*


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**Albert J. Sandel,** core department superintendent at Symington-Gould Corp., Depew, N. Y., has completed 50 years of service with the company. In point of continuous service, he is the oldest member of the supervisory staff. All these years have been spent in the core department, where he has held practically every job.

**Arthur E. Thode** has been appointed industrial advertising manager for the Tractor Div., Allis-Chalmers Mfg. Co., Milwaukee.

**J. A. Johnson**

**Joseph H. McConnell** has been elected a director of Reynolds Metals Co. and appointed general counsel of the company. He succeeds the late Judge Robert P. Patterson, former Secretary of War, who was killed in a plane accident.

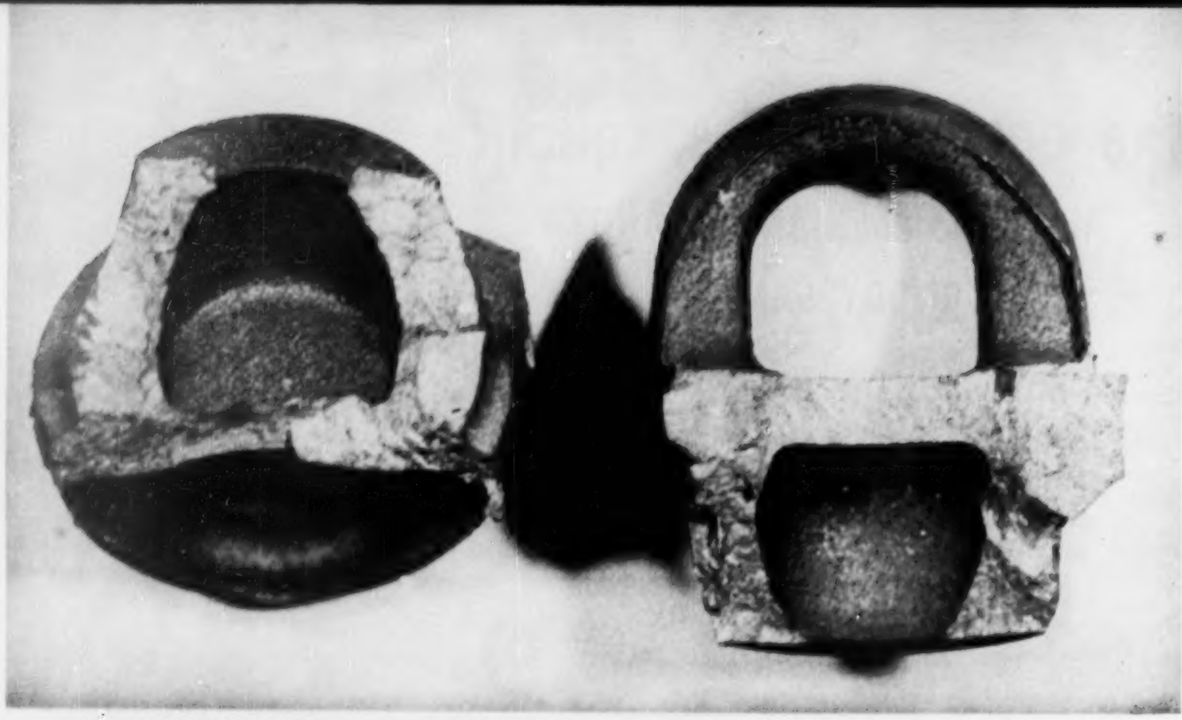
**Harry H. Reich,** has broadened his foundry equipment sales services to include representation for Modern Equipment Co., Port Washington, Wis.

**Charles E. Hall** has been appointed works engineer of both the Cincinnati and Taylor, Ky., plants of Charles Taylor Sons Co., a subsidiary of National Lead Co.

**Arthur G. Paugh** has been appointed assistant director of purchases of the Vanadium Corporation of America. Mr. Paugh will headquarter in the corporation's General Purchasing Dept., New York.

**Arthur R. Lytle** has been appointed vice-president in charge of research for Electro Metallurgical Co., a Div. of Union Carbide and Carbon Corp. He has been associated with the corporation since 1923.

*continued on page 79*



Surface checks and hot cracks result when metal lacks strength to resist contractive forces of solidification.

F. W. JACOBS / *Chief Metallurgist*
*Texas Foundries, Inc., Lufkin, Texas*

# HOW WE SOLVED OUR HOT CRACKS PROBLEM

## The malleable iron was too refined and the sand was too insulating

■ Hot cracks are probably more disturbing than any other single scrap defect normally encountered in malleable iron castings. They are most difficult to analyze and to correct. Often the difficulty in finding the source of the crack leads to gating changes, cracking strips, or casting redesign. These are expedient, rather than positive remedies of the basic cause.

We find the melter looking to the sand, the sand foreman looking to the metal, the molding foreman looking to sand and metal as well as gating and design. In turn all look to the pattern shop for faulty gating, while the pattern shop takes a good look at molding practice, sand, and metal and finally declares the design is no good.

The following definition is applicable: *"Hot cracks and checks in a casting are the result of the metal lacking sufficient strength at any given point to resist the contractural forces exerted during solidification."*

Provided there is a casting design and gating which has heretofore been applied successfully, this lack of strength may be due to outside forces such as sand, improperly made or improperly used on a job, or it may be due to inherently weak metal as a result of grain size, shrink voids, or impurity. It is possible to take any reasonable design of casting, apply a gating system, apply a sand, and pour a metal into the mold which for that casting will result in a sound, crack-free structure.

Unfortunately, these same conditions do not always satisfy the next casting. It therefore becomes necessary in a production shop to produce a metal and a sand which if correctly used will satisfactorily produce the highest possible percentage of good castings from the many designs normally encountered, thus leaving only a small percentage of jobs to be given special treatment.

This article deals principally with the occurrence in castings of cracks and checks which were believed to be caused by pouring too refined a metal into sand which was too insulating.

### HOW WE MAKE OUR IRON

The iron in the author's plant is made by the duplex process. Melting is done in a cupola lined to either 48 in., 54 in. or 60 in. dependent on the production requirements. The cupola is charged by skip hoist. The blast is dehumidified by an 80-ton capacity refrigeration unit and supplied to the cupola by a centrifugal blower. Slag is separated from the metal by front slagging and is quenched in water for easy visual examination. The melting rate varies from 10 to 15 tons per hour. The cupola tap temperature averages 2780 to 2810 F.

The air furnace holds 34 tons; the average bath varies between 20 and 30 tons dependent on production rate. The furnace is fired with No. 5 fuel oil. Metal is tapped from both sides at 2840 to 2850 F. Combustibles in the air furnace atmosphere are measured by means of a heat prover, the gas samples being drawn from the atmosphere passing over the back bridge wall.

The average cupola charge is shown in Table 1.

The metal at the cupola spout is analyzed once per hour for carbon.

Air furnace metal is analyzed for carbon every half hour, silicon and manganese every hour, sulphur ev-

TABLE 1 . . CUPOLA CHARGE

| | |
|---|---|
| Metal charge | 2000 lb |
| Silvery pig iron | 1-3% |
| Malleable pig iron | 9-11% |
| Malleable scrap | 2% |
| Steel | 36-38% |
| Sprue | 50±% |
| Lump ferrosilicon (boron contained) | ¾±% |
| Coke split | 240-270 lb |
| Limestone | 60 lb |
| Flux | 4 lb |

ery two hours, phosphorus and chromium three times per day coinciding with the pouring of test bars.

Silicon carbide briquets have been used in the charge for deoxidation. Ferroboron is added to the metal if necessary for control of abnormal chromium contents.

In addition to the above, furnace sprues are poured every half hour, quenched and broken for fracture control of mottle. Test plugs 2 in. square by 10 in. in length are poured four times daily, allowed to cool in the sand, then are broken for fracture examination to control of mottle. These plugs are annealed and samples taken from the center and outside of one plug from each heat for microstructure examination.

Target analysis limits are given in Table 2.

Control of operation and analysis is maintained within close limits to assure production of ASTM 35018 malleable iron. Complete heat data is registered daily on the melting log. Control charts for raw materials operation variables, chemistry and physical properties are maintained for easy reference.

TABLE 2 . . ANALYSIS LIMITS

| | |
|---|---|
| Carbon | 2.40-2.47% |
| Silicon | 1.08-1.12% |
| Manganese | 2×S+15 to 2×S+20 |
| Sulphur | 0.16 max |
| Phosphorus | 0.10-0.13% |
| Chromium | 0.035 max |

Several years ago, production of metal under the above controlled conditions in the author's plant proceeded as standard. The scrap produced in the foundry was the lowest on record for the company. Then an increase in scrap, part of it due to hot checks and shrinks, became apparent. The increase was gradual until the bottom dropped out so to speak.

At this time the scrap due to cracks was in the form of hot checks and shrink cracks. Examination of fractured castings revealed large dendritic grains, often accompanied by shrinkage areas. The iron being produced mottled easily at normal analyses.

Typical examples of the type fractures and cracks are shown in the illustrations. All of the jobs shown were poured without trouble prior to the period when the cracks became frequent. The same gating was used throughout.

First glance at the situation led to the conclusion that the metal being produced and poured was solidifying too slowly in the mold for the type sand and gating being employed. Steps were immediately taken to alter this. Following are some of the problems and factors we encountered.

## FACTORS OF FLUIDITY

In past years many of the hot cracks in the author's plant may have been due to iron oxide impurity resulting from over-oxidation of metal in the melting process. But it was now generally conceded that most of the present cracking trouble was due to excessive grain size, dendrites, possibly due to a very low percentage of the iron oxide impurity in the iron. Grain size is affected by the fluidity of the metal. Fluidity is the measure of the time elapse in the cooling of metal from the pouring temperature to and through liquidus range where metal starts solidifying in the form of dendrites.

Many factors are involved in the mechanics of fluidity and size of dendrite with regard to iron solidification. Some of them are:

- The more rapid the cooling of the iron, the finer the grain size.
- The more impurity in the iron as inclusions, the faster an iron will set up and produce smaller dendrites.
- Temperature of pouring affects fluidity more than any other factor in the normal commercial iron. The higher the temperature, the more the fluidity.
- Analysis affects fluidity as follows:
  - Carbon increases fluidity
  - Silicon increases fluidity
  - Phosphorus increases fluidity
  - Raw material in the charge affects fluidity—the higher the steel content, the less fluidity.
- Deoxidation affects fluidity—the more a metal is deoxidized the less the impurity, the more the fluidity. The degree of oxidation in the blast furnace when producing pig iron affects the iron oxide content of the pig iron and will subsequently have a bearing on the fluidity of the duplex metal depending on the type and amount of pig iron used in the charge.
- Atmosphere affects fluidity—hydrogen decreases fluidity.
- Factors relating to the mold affect fluidity.
  - Static and velocity head
  - Size and shape of mold
  - Composition of mold
  - Mold temperature
- Transportation of liquid iron from furnace to pouring floor affects fluidity.
  - Size and design of ladle
  - Temperature of ladle
  - Time of transportation

Fluidity must be controlled in a manner to eliminate hot checks without creating excessive misruns.

## OUR MELTING OPERATION

### Cupola Operation

**Coke.** One of the noticeable changes in operation was the amount and size of coke per split being used in the cupola with relation to final carbon content (Table 3). Prior to the use of dehumidifying equipment on the cupola blast it was the practice to adjust the coke split to take care of excess moisture in the blast. We added 10 lb coke per split per one grain per cu ft increase o fmoisture. With this adjustment the amount of coke used on the excess side with resultant cupola carbons running between 2.70 per cent and 2.80 per cent as in period 1. In period 2, with the advent of the humidity control on the cupola blast, the coke split averaged 240 lb with little variance upward. Resultant cupola carbons averaged 2.65 per cent to 2.75 per cent showing a slight drop over previous runs.

In period 3, an endeavor to cut the coke split as an economy move was made until finally the splits

TABLE 3 . . COKE VS. CUPOLA CARBON

| Period | Coke Size in. | Coke Split lb | Carbon per cent | Scrap |
|---|---|---|---|---|
| 1 | 2×7 | 240 up | 2.70-2.80 | Low |
| 2 | 2×7 | 240 | 2.65-2.75 | Low |
| 3 | 2×7 | 210-220 | 2.60 avg. | High |
| 4 | 3×4 | 210-220 | 2.55-2.60 | Very High |
| 5 | 3¾×6 | 240 | 2.70-2.80 | Low |

**Were hot cracks** caused by over-refined metal in an over-insulating sand?

**Defects appear at the trademark.**

averaged 210 lb to 220 lb. Cupola carbons dropped to 2.60 per cent average during this period.

The final step as far as coke is concerned was to change from a 3 x 7 in. size coke to a uniform 3 x 4 in. size. Resultant cupola carbons in period 4 dropped to 2.55 to 2.60 per cent.

All this meant that with a cupola carbon so low it was increasingly difficult to hold a 2.40 to 2.47 per cent carbon in the air furnace iron without resorting to detrimental operational changes in the furnace practice.

Steps were taken to increase the cupola carbon back to the 2.70 to 2.80 per cent range. This was done by increasing the coke split and size, maintaining sufficient carbon in the base charge and adjusting tuyere ratios and cupola diameter to maintain a uniform blast penetration for the melting rate required. Hourly checks on cupola carbon were made by the laboratory.

▪ **Silicon loss.** As a measure of iron oxide content in the metal it was decided to use per cent silicon loss in cupolas operation as a criteria. This measure was of course correlated with the color of the slag. Figuring that more iron oxide in the final metal would decrease the fluidity and enable the castings to be poured with resultant smaller grain size and less dendrite structure, a program of gradually increasing the silicon loss was instituted until such time as hot checks would disappear. (Table 4).

The use of silicon carbide as a deoxidizing agent had been prevalent, so naturally a silicon loss of 20 per cent when using silicon carbide represented lower iron oxide contents in the slag and metal than a 20 per cent silicon loss when operating without silicon carbide.

The silicon loss during the bad period of shrinkage and hot checks averaged 22 to 25 per cent when using silicon carbide. Little change was noted in hot check propensity as silicon losses were gradually increased until the day that the silicon carbide was taken out of the charge. This change afforded more iron oxide to the metal and decreased fluidity. Another change in charge was made simultaneously by switching from a low iron oxide content pig to a higher iron oxide content pig. This in itself afforded more iron oxide content to the metal.

Hot checks and shrink were decreased to a minimum as a result of this change.

Further increase of silicon loss was gradually made over another two week period until the loss reached 28 to 32 per cent. At this stage another epidemic of hot cracks occurred but more as hot tears from weak metal accompanied by an increase of misruns.

**TABLE 4 . . SILICON LOSS IN CUPOLA**

| Period | Silicon Loss per cent | Deoxidizer per cent | Iron Oxide in Iron | Scrap |
|---|---|---|---|---|
| 1 | 23-24 | 1/3 | Low | Low |
| 2 | 24-27 | 1/3 | Avg | Low |
| 3 | 22-25 | 1/3 | Low | Increase |
| 4 | 25-26 | None | Avg | Low |
| 5 | 28-32 | None | High | High |

Thus establishing a lower and upper limit of oxidation loss in the cupola, the control of cupola operation was set to allow a 20 to 24 per cent silicon loss without use of silicon carbide for deoxidation and by using a pig iron melted under more oxidizing conditions. Recent work has shown that the color of the cupola slag is of prime consideration in melting to a target silicon loss. A medium dark green slag generally coincides with an average 23 per cent silicon loss.

**Furnace Operation**

▪ **Carbon removal and flame-metal reactions.** About the time that the cupola was producing the lowest carbon metal and coincidental with the start of the serious hot check problem, it was decided to run a higher carbon base metal from the furnace in an attempt to produce an iron approaching the micro mottle range. This was based on studies by R. W. Heine and associates which showed that iron in the range of 2.50 to 2.55 per cent carbon had more hot tear resistance because of micro mottle. Thus, by running a cupola iron of 2.55 to 2.60 per cent carbon, the oxidation of carbon in the air furnace was limited to about 10 points.

In order to accomplish this it was necessary to keep the bath almost entirely covered with slag to prevent excess carbon reduction and to prevent the necessity of excess coking to maintain carbon.

With such an operation there was little action of the flame on the bath and little chance for normal oxidation reactions to take place.

The bath was completely covered with a composition of grog and lime at the start of the drain period immediately after the cupola was out. In so doing, the oxygen in the flame was prevented from combining with the iron to form $CO_2$, CO and FeO. Thus the iron oxide in the metal reacted with the slag in attempting to come to equilibrium, resulting in lower iron oxide content in the metal. This metal, particularly on the drain period of the heat, became very fluid because of its refinement and when poured was so slow in setting up that shrinks and hot checks predominated.

Such were the conditions at the peak of the trouble.

The immediate corrective step at this stage as far as air furnace operation was concerned was to skim off the slag and keep the bath at least 50 per cent open. This allowed proper flame reaction on the metal and was comparable to previous practice.

In order to allow normal carbon reduction rates per hour it was felt necessary, in addition to tapping a cupola metal in the 2.70 to 2.80 per cent carbon range, to lower the target range of carbon in the base furnace metal of 2.40 to 2.47 per cent, where it had been previous to the cracking trouble.

▪ **Carbon reduction rate.** An important consideration immediately followed. It was felt that in order to maintain a closer balance with reaction rates in the furnace, the average cupola melting rate not only had to balance the pouring rate in the foundry but the size of bath had to be in closer relation to pouring rate of 10 tons per hour it was felt that the bath size had to be 20 to 25 tons or 2 to 2-½ times the pouring rate.

This would allow a 15 point carbon reduction per hour at the newly established carbon targets for both cupola and furnace. When cupola carbons run lower, the size of bath must be less to accomplish the same rate of carbon reduction. A bath too large would force conditions toward excess fluidity and exce ; temperature. A bath too small would lead to lower fluidity and insufficient time for proper mixing of the cupola metal.

▪ **Furnace Atmosphere.** Equally important in the maintenance of uniform reaction rates in the furnace is the type atmosphere over the bath. The desired final carbon content can only be maintained, provided the rate of flow of metal through the furnace and the size bath are held constant, by firing with a flame which will give desired tap temperature without excessively oxidizing the bath and without excess refractory wear. Much depends also on producing a constant temperature cupola metal so that heat input to the furnace by means of the fuel can be held at a constant rate per ton per hour.

**Transfer of Iron**

As mentioned above, temperature of pouring is important in the control of fluidity and grain size of the metal. At a constant tap temperature, analysis, melting procedure and base charge, the temperature of pouring varies somewhat with the tonnage being poured. At higher tonnages the pouring ladles make more trips to the furnace and consequently lose little heat. This results in undesirable higher pouring temperatures.

Much depends on the size ladle being used to pour a job or series of jobs. The larger ladles lose less

heat than the smaller ladles which results in pouring excessively hot. Since large ladles are generally used to pour the larger molds containing heavier sectioned castings, the trouble caused by pouring too hot becomes magnified.

Care must be taken not to pour too many molds from one ladle as the temperature loss during the pour is extended. In this case, in order to pour the last mold without misruns, the first mold quite often is poured too hot.

When pouring more than one conveyor of castings from one ladle or iron, production must be planned to allow pouring thin section work first and heavy section work last out of a ladle.

Heavy work should be furthest from the furnace and light work closest.

Unless a system of transfer is laid out to prohibit pouring some of the work too hot, frequent temperature checks with an optical pyrometer should be made to control maximum pouring temperatures.

Any change in basic melting practice that alters the fluidity of the metal can easily upset the control of pouring temperature in the foundry.

Under normal conditions castings in the author's plant are generally poured at a maximum of 2730 F. Jobs that tend to crack, hot check or shrink are poured at a maximum of 2700 F. During the period of excess fluidity some jobs were poured at a temperature as high as 2760 F.

Considerable study of pouring temperatures and heat loss in transfer was made to determine what changes in the monorail system, ladle size, transfer from ladle to ladle, etc., would have to be made to make it impossible to pour too hot. This study indicated losses in transferring from furnace to pouring station as high as 240° and as low as 80°. Losses during pouring itself varied from 10° to 100°. Thus when closely analyzed there was found considerable room for improvement in metal handling. Temperature, as we know, is a most important consideration in controlling fluidity. Even the closest control of the melting operation will not offset a poor control of handling.

## Chemical Analysis

Metal analysis plays a part in the control of fluidity. It is common knowledge that increase of carbon and/or silicon will increase fluidity.

TABLE 5 . . CHEMICAL ANALYSIS OF RESIDUAL ELEMENTS

| Sample | W | D | M* | H |
|---|---|---|---|---|
| Ni | <0.01 | <0.01 | <0.01 | <0.01 |
| Mo | <0.005 | <0.005 | <0.005 | <0.008 |
| Cu | 0.42 | 0.13 | 0.08 | 0.26 |
| Va | 0.007 | 0.005 | 0.006 | 0.005 |
| Ti | 0.02 | 0.02 | 0.02 | 0.01 |
| Sn | 0.02 | 0.02 | 0.01 | 0.01 |
| Al | 0.007 | 0.006 | 0.006 | 0.005 |
| Mg | <0.005 | <0.005 | <0.005 | <0.005 |
| Zr | <0.005 | <0.005 | <0.005 | <0.005 |
| Bi | 0.001 | <0.001 | <0.001 | <0.001 |
| Co | <0.005 | <0.005 | <0.005 | <0.005 |
| Pb | <0.003 | <0.003 | <0.003 | <0.003 |

Antimony and arsenic not detected.

*Iron from another malleable foundry.

Percentagewise, a carbon increase of 0.05 per cent is equivalent to a 0.20 per cent increase of silicon and a 0.10 per cent increase of phosphorus. This in turn is equivalent to a 4 F increase of temperature.

The investigation of hot cracks included some work on desulphurizing in the ladle by calcium carbide and dry nitrogen injections. Although we were able to desulphurize from a 0.116 per cent sulphur down to a 0.056 per cent sulphur, we found the metal difficult to handle from the slag standpoint and very cold. The desulphurization did increase fluidity considerably because on test runs thin sectioned work was poured as low as 2530 F without misruns. This decrease of sulphur did not eliminate the cracks in the samples poured and work was temporarily discontinued.

The phosphorus content of the metal at the worst period of cracking averaged 0.100 per cent as compared with 0.095 per cent in previous periods. It was felt that lower phosphorus might help to lower fluidity so a series of heats was made with the phosphorus as low as 0.070 per cent. No difference in overall cracking tendencies was noticed. Tests were made on individual jobs where 0.03 per cent phosphorus was added to the ladle. On those jobs where cracks were due to excessive feeding, which created hot spots and unequal cooling, the phosphorus addition seemed to promote a better feeding action with less cracking tendencies. On those jobs where cracks were due to insufficient or border line feeding, the phosphorus addition did no good.

TABLE 6 . . RAW MATERIAL CHARGE

| Period | Steel per cent | Graphitic Charge per cent | SiC | Type Pig Iron | Scrap |
|---|---|---|---|---|---|
| 1 | 39 | 11 | 1/3 | $A_1$ | High |
| 2 | 39 | 11 | 1/3 | B | High |
| 3 | 33 | 17 | 1/3 | $A_1$ | Very High |
| 4 | 33 | 15 | 1/3 | $A_1$* | Very High |
| 5 | 35 | 13 | None | C | Low |

*Kish-bearing pig

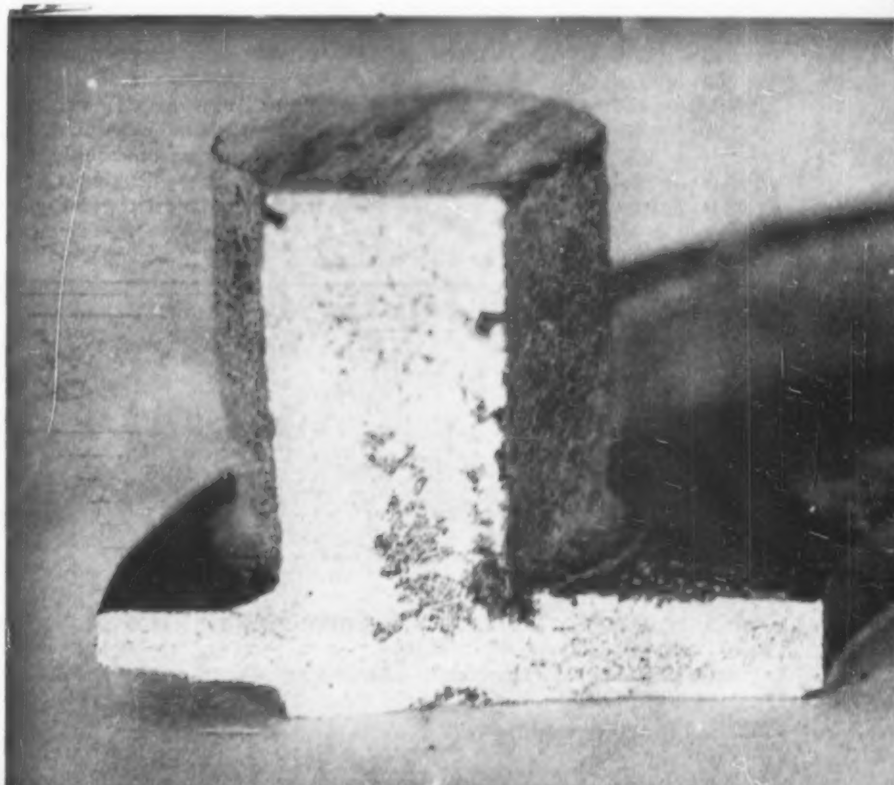
Two heats were run by adding 0.03 per cent phosphorus to the furnace bath in half hour intervals to give a final 0.125 to 0.130 per cent phosphorus. Overall cracking tendencies were not reduced.

Addition of 0.03 per cent phosphorus to the old type test bar which was overfed resulted in increased physical properties. Additions to the new type test bar which has a more uniform feeding system did not improve properties nearly as much.

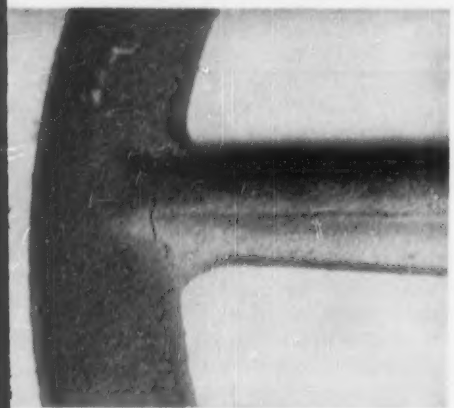
Analyses for residual elements were made on three jobs giving trouble with shrinks and hot cracks. A sample of iron from another shop which was not having a cracking problem was also analyzed. Results are shown in Table 5.

With the exception of copper, no

**Fracture** shows shrinkage condition and accompanying dendritic structure.



**Iron oxide** content is limited.



**Slag color** indicates iron oxide.

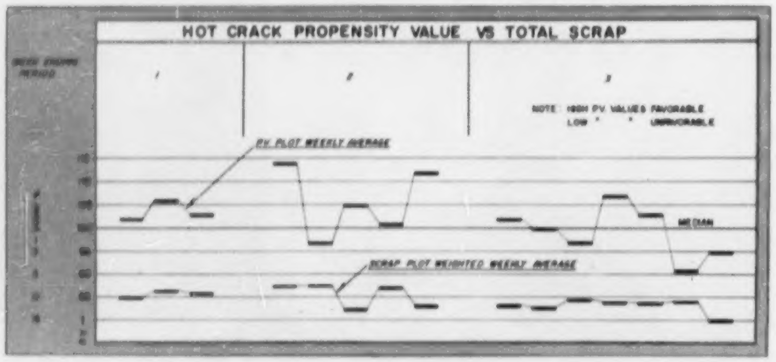
element was present in excess so it was felt that chemistry of the residual elements was not a factor. The high copper content is a result of a ladle addition. This has been standard for these jobs for some time and was not found to have a bearing on hot crack propensity.

The possibilities of the raw materials in the base metal cupola charge having a bearing on the shrinkage of the iron were not overlooked. Various trials of a week to 10 days duration were made in which pig iron from three different sources was compared. At the time of the first substitution the base charge consisted of 39 per cent steel, 50 per cent sprue, 8 per cent pig iron, 3 per cent domestic malleable scrap and silicon carbide briquets (Table 6). No difference was noticed in cracking tendencies. Later it was decided to lower the 33 per cent and raise the pig iron and malleable scrap to 17 per cent of the charge. This tended to give more fluid metal and any other changes in the operation to render a less fluid metal were nullified.

A slight change was then made by raising the sprue charge to 52 per cent and lowering the pig iron charge, making the total graphitic charge 15 per cent. This was a step in the right direction except that coincidentally with the change a new car of pig iron was used which was an extremely high carbon, low oxide metal. Examination of the pig fracture revealed an excess amount of kish material, a result of pouring this highly reduced blast furnace metal into the pig molds at too low a temperature.

The kish in the pig acted as a powerful inoculant and evidently raised the fluidity of the metal since the shrink and hot check tendencies in the castings being produced at that time became very pronounced.

The charge was then changed as mentioned previously by switching to a lower carbon, higher oxide pig, by eliminating silicon carbide from the charge as a deoxidizer, and by raising the steel content to 35 per cent and cutting the graphitic charge to 13 per cent.




**Operating conditions** are used to determine tendency towards hot cracks.

This change of charge was largely responsible for the drastic diminishing of the shrink and hot check problem due to low oxide content in the metal.

The fact that such a high percentage of returns in the form of sprue and malleable scrap continued to be used in the charge made further decrease of fluidity in the final metal proceed at a slower rate than desired.

### Hydrogen

It is generally believed that hydrogen in the metal decreases fluidity. Observation of shrink voids in the castings led to an investigation of hydrogen as a source of trouble even though the trouble was believed to be caused from excess fluidity. The biggest source of hydrogen would be from the cupola blast. The moisture in the blast was being controlled at 3.0 grains per cubic foot during the worst siege of hot cracks and shrinkage, this being below the moisture content in the blast during the period of normal operation prior to the installation of dehumidifying equipment.

### Hydrogen-Slag Conditions

Moisture in the atmosphere varied from 1.9 to 8.0 grains per cubic foot during the period investigated, thus the moisture in the furnace atmosphere would vary in like amount. The amount that would be absorbed by iron depended on the temperature of the bath, the amount of slag covering on the bath and the amount of hydrogen or moisture in the blast. The amount of hydrogen removed from the bath depended on the Fe, $O_2$, CO, $CO_2$ reactions in the bath at various stages of metal refinement in the air furnace.

The amount of hydrogen absorbed would be greatest at higher temperatures over an open bath free from slag protection. To carry a slag-free bath would necessitate running a cupola metal very high in carbon to prevent too low a carbon being tapped from the air furnace under normal firing practice. The open high carbon bath would permit greater oxidation of the metal forming FeO and CO, this reaction in turn being most favorable for removing hydrogen.

Conversely, a slag-covered bath into which was tapped low carbon cupola metal would be less likely to pick up hydrogen but at the same time less likely to free hydrogen because of the reduced FeO, CO gas reaction. Thus it became a matter of choice, knowing that the hydrogen in the cupola metal was constant, as to which set of conditions would leave the most hydrogen in the final metal product tapped from the furnace.

Experience revealed that the iron produced under the condition of slag covering and low carbon removal acted the most fluid and resulted in more cracked castings. Therefore if hydrogen were the factor it could be reasonably argued that the cracked castings in this case were not due to a high hydrogen content because increase of hydrogen should reduce fluidity.

In order to prove the point further, several methods of removing hydrogen from the metal were employed.

### Hydrogen Removing Methods

- Cupola carbons were increased and less slag was carried on the air furnace bath. This allowed more boil to take place in the furnace iron, the removal of the reaction gases of iron and carbon facilitating hydrogen removal. This practice was maintained as necessary for carbon removal as well as to increase the oxide content in the metal.
- The metal in the air furnace was agitated by poling with green saplings at regular half hour intervals during the day. No difference in cracking tendency was noticed and the violent agitation created excessive refractory wear.
- Iron ore was added to the bath to stimulate FeO reactions to enhance hydrogen removal. This too was impractical from the refractory wear standpoint and also interfered with analysis control.
- Dry nitrogen was injected in the ladles of iron by means of a long graphite tube. This practice is being continued on certain jobs because the agitation affords an easy method of temperature reduction and helps to cleanse the iron of entrapped slag.

Results of trial methods indi-

cated no reduction in cracking tendencies of the iron during the experimental periods and it was concluded that hydrogen could only be a contributing factor because its content in the metal was already too low, thereby tending to increase metal fluidity.

## WE STUDY WEEKLY TRENDS

A method was devised to evaluate each heat and/or each week's operation to express quantatively the existing propensity toward hot cracks. Operating conditions, measured by metallurgical, physical and enviromental data, were tabulated to show daily and weekly averages.

Three separate periods totaling 15 weeks operation were studied because they included instances of high and low overall scrap production and because they also included occasions when substantial changes were made in melting procedures.

All hard iron scrap reports for the periods under consideration were inspected and from them 18 castings which showed hot cracks in excess of one per cent two or more times were selected and carefully studied in an effort to eliminate variables or to make allowance for known variables by judicious weighting. It was believed that careful correlation of information revealed on existing records would make possible the development of Propensity Values just as effectively as if test patterns of a design intended to reveal tendency towards hot cracks had been periodically poured.

Soft iron scrap records for the same periods were examined and a listing of every occurrence of hot crack rejection for the castings under study was made. In most instances, it was possible to relate soft iron scrap to the heat from which the defective castings were poured. In a few cases where this was impossible, pro rata distribution was made of the soft iron scrap in question over the two or three heats involved.

A check was made to see if pattern changes were made on any of the 18 jobs involved. Only three such instances were found. If such pattern changes affected the hot crack propensity the values obtained were again weighed.

Key personnel in the plant were consulted and it was determined that the 18 castings involved represented a true cross section of the problem.

Each of the patterns under study was listed to show date produced within periods being studied, total pieces poured, pieces scrapped for hot cracks in both hard and soft iron.

From this listing it was necessary to work out a coded ratio by adding 50 per cent of production to total scrap in order to arrive at values which would reflect a consistent curve above and below a mean value. The coding formulas are as follows:

(1) $\text{Propensity Value} = \dfrac{\text{Mean Coded Ratio}}{\text{Individual Occurrence Coded Ratio}}$

(2) $\text{Coded Ratio} = \dfrac{0.5 \text{ Total Production} + \text{Scrap}}{\text{Total Production}}$

(3) Mean Coded Ratio = Mean of individual coded ratios for all occurrences of one casting during periods under study.

As an example, casting *A* produced 136 pieces on a single heat. Of these, 14 pieces were scrapped for hot crack in hard iron and 4 pieces scrapped for hot crack in soft iron for a total of 18 pieces scrapped.

$$\text{Coded Ratio} = \frac{0.5 \times 136 + 18}{136} = 0.63$$

Obtain Coded Ratios for all days of production of casting *A* during period under study and obtain the average under formula (3).

Where for example the Mean Coded Ratio would be 0.563 for 10 days of production then by applying

$$\text{Propensity Value} = \frac{0.563}{0.63} = 89$$

The Propensity Value obtained above indicates that for this particular day's production hot crack occurrence was above average for that job. Propensity Values above 100 indicate low hot crack occurrence; values below 100 indicate high hot crack occurrence.

Curves were plotted for the periods studied using weekly average values. Where hot cracks occurred on three or more jobs in any given day average daily values were plotted.

Curves were also plotted as shown to show total scrap averages for the same period. In comparing total scrap to hot crack scrap it was found that total scrap did not vary with hot crack scrap. This comparison substantiated an earlier contention that relates to a psychological factor in dealing with hot cracks.

In any period when hot cracks become a part of the scrap picture there is an inclination to concentrate on the hot crack scrap at the expense of controlling normal foundry scrap. This results in higher overall scrap and the general tendency is to blame high scrap production on the hot cracks.

Experience in the author's plant has shown that the hot crack scrap in the periods under discussion rarely amounted to over 1.0 per cent of total production. This factor led us to tally the scrap on hard and soft iron production each day by weighing and reporting scrap due to hot cracks as a separate percentage figure. This is recorded along with total scrap percentages on the melting log each day. Scrap percentages due to hot cracks now average 0.1 to 0.2 per cent each day with the soft iron scrap running slightly higher.

It was decided to correlate melting variables with propensity values and some 67 items were analyzed under the following general headings:

Basic charge: 1. Graphitic charge; 2. Sprue; 3. Steel; 4. Charge alloy; 5. Coke; 6. Flux; 7. Limestone.

Furnace additions

Ladle additions

Furnace analysis

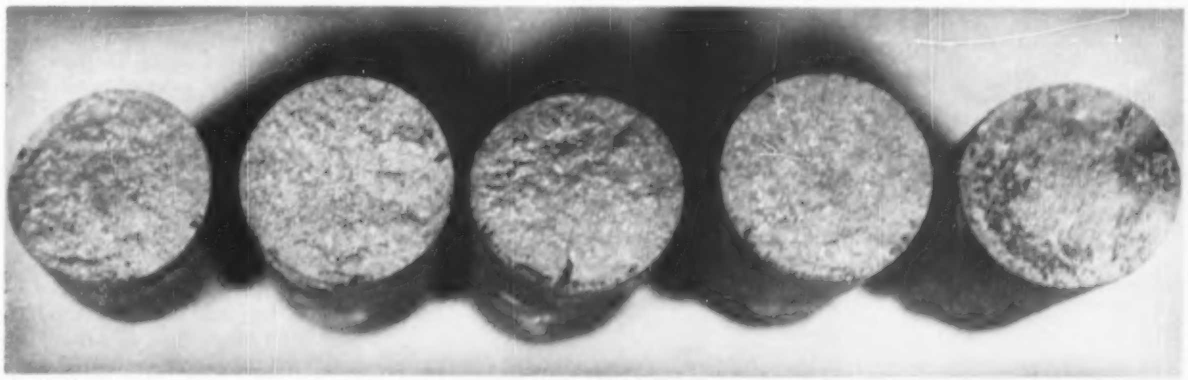
Logistics

Weekly data of the above elements was compiled by listing daily data and then getting a daily average for the week. The figures do not necessarily reflect actual operations since daily operations within a given week were sometimes changed. These average daily figures for each of the weeks considered do, however, indicate trends.

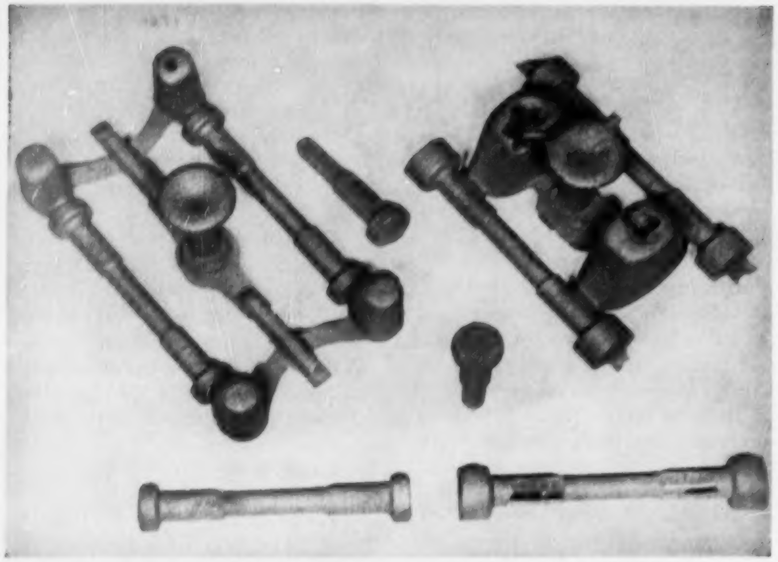
Definite trends were observed as listed in Table 7.

The above study agreed in general with visual observation and corrective measures taken regards melting procedures during the operating period discussed earlier.

The factors in the "Good Days" column, such as lower malleable scrap, higher steel, lower manganese briquets, higher moisture content and less cupola shut down time all agree with the concept that the



**Comparison of fractures** of sprues cast at the air furnace in different sands. Left to right, fine new sand, coarse new sand, system sand ("good period"), system sand ("bad period"), and high cushioning sand.



**New gating at right eliminated hot spots, trapped slag, increased yield.**

iron producing the least hot crack, hot check, and shrinkage trouble was also the least fluid.

Melting procedures were then standardized based on the statistical study as well as on practical conclusions conceived from observation of melting practice during the period. The limits placed on melting factors as listed in Table 8 are believed to be consistent with good operating days and should serve to standardize melting operations at a level which will enable the foundry to bring such items as gating, yield and scrap under a measurable control with respect to metal.

Adherence to these limits has resulted in fewer problems due to hot checks and shrinkage. Silicon loss at best can only be an approximate figure due to inability to figure exactly the silicon content being charged. This factor is closely associated with cupola slag color as affected by iron oxide content and therefore both factors are considered together.

The feeding and gating system of any casting must be designed to accomplish directional solidification with minimum chance for created hot spots which might affect the grain size and strength of the casting both at elevated and room temperatures. In the illustration of two types of feeding systems on test bars, the feeders on the old type test bar to the left created hot spots in the ¾-in. diameter sections. This made it necessary to pour the test bars at carefully controlled temperatures to prevent unduly large dendritic grains at the mouth of the feeder. Many test bars were broken or cracked when sprued. The extra fluidity of the iron also created a shrink condition in the center of the bar which in addition to large grain size lowered the physical strength of the bar.

The gate of bars to the right was designed to eliminate hot spots. These bars can be poured over a wider range of temperatures. In addition, the yield was increased, dirt and slag are more easily trapped, the sprueing operation does not crack the bars and grinding of gates is eliminated.

TABLE 7 . . MELTING VARIABLES VS. HOT CRACK PROPENSITY

| Variable | "Good Days" | "Bad Days" |
|---|---|---|
| Malleable scrap | 2.6% | 4% and over |
| Steel | 39.2 to 38.3% | 36.1 to 32.3% |
| Manganese Briquets | 0.74 to 1.48 lb/ton | 3.00 to 5.33 lb/ton |
| Limestone | 47.5 to 48.0 lb/ton | 62.7 to 62.8 lb/ton |
| Furnace Analysis | | |
| Mn | 0.50 to 0.48% | 0.48 to 0.44% |
| S | Generally lower on bad days and weeks | |
| P | 0.106 to 0.086% | 0.093 to 0.077% |
| Cr | Generally higher on bad days and weeks | |
| Moisture | 6.0 to 8.0 gr/cu ft | 1.9 to 2.0 gr/cu ft |
| Shut Down Time (Cupola) | 17 to 67 min | 114 to 281 min |

Other possible trends observed:

% Silvery pig iron

% Lump ferrosilicon

% Elongation of test bars

% Silicon, manganese and carbon losses (with related factors)

## Sand

Much has been written about shrinkage of metal due to sand. Although the primary purpose of this paper has been to discuss melting variances, certain changes in sand practice in the shop produced a sand which was more insulating. The peak of this condition coincided with the peak of the hot check and shrink difficulty.

As a result of a drive for better finish, changes in grain fineness of the sand were made by reducing the amount retained on the 40 through 70 mesh screens by 10 per cent of the total and increasing that retained on the 100 through 200 mesh screens by a like amount. The fines material increased from 5.0 per cent to 7.5 per cent on one unit and from 8.0 per cent to 11.5 per cent on another unit. Permeability of the sands dropped from a range of 115-128 on the heavy unit to a range of 77-90, and on another unit it dropped from a 105-126 range to a 65-82 range.

Meanwhile a slight increase of additions in the form of bond, seacoal and cereal was made to offset an increased amount of new sand additions. Green strength rose slightly and moisture held about the same.

The net effect seemed to be that of an insulating sand, one which when jolted and rammed packed tight at the sand-pattern interface, prevented easy escape of steam and gas. This condition prevented rapid cooling of the iron and contributed to the hot check and shrink problem.

TABLE 8 . . LIMITS PLACED ON MELTING VARIABLES

| | |
|---|---|
| **Metal Charge** | |
| Total pig iron | 10-12% |
| Malleable scrap | 2% |
| Sprue | 50% ± |
| Total steel | 35% min |
| Lo phos plate & struct. | 10% max. |
| 50% lump FeSi (boron) | 0.75% max. |
| Carbon-base charge | 1.80% min. |
| Coke | 240 lb/ton min |
| Limestone | 50 lb/ton |
| **Cupola Operation** | |
| Cupola carbon | 2.70-2.80% |
| Cupola shut down time | Minimize |
| Silicon loss (without silicon carbide deoxidizer) | 20-24% |
| **Furnace Operation** | |
| Fuel Oil | 50 gal/hr min |
| Furnace Tap Temperature | 2840-2850 F |

## Conclusions

This work has shown that for a given gating and pouring system in the foundry the iron oxide content in the iron must be held within a defined range. If it is too low and the iron becomes too fluid, shrinks, large dendritic grains, hot checks and cracks will result. If the iron oxide content is too high, the iron becomes faster setting and develops intergranular weakness. Again shrinks and hot cracks will result but will be accompanied by misruns and blows.

Iron oxide in the iron can be basically controlled by watching the color of the cupola slag and the color of the furnace slag. The darker the slags the more iron oxide. Chemical analysis of the slags for FeO content is an added control check. Our operation is controlled to 5.0 to 6.0 per cent FeO in the cupola slag and 12.0 to 15.0 per cent FeO in the furnace slag.

Fluidity can be easily checked by periodically pouring the standard fluidity tests under carefully controlled pouring conditions. Results of these control checks are relative but should suffice as an aid in control of hot cracks, checks and shrinkage for any given gating application in any given plant operation. Close harmony in operating the cupola and furnace as relating to foundry tonnage requirements will allow sufficient control of oxidation reactions to maintain the desired fluidity of the iron.

# SMALL CUPOLA SPORTS NEW BONNET

*$300 in labor and materials reduced a fire hazard and eliminated smoke and fumes. University of Wisconsin bonnet cools better, scrubs stack gases.*

HARRY W. WEART/*Instructor*

■ Most cupolas operated industrially are covered at the top by a spark arrester only. Others have various bonnet arrangements for recovering fly ash by either wet or dry methods.[1] The University of Wisconsin has further improved its cupola[2] by installing and operating quite successfully a closed, water-cooled bonnet for the primary purpose of cooling cupola exhaust gases and preventing both hot gases and sparks from creating a fire hazard to adjacent property.

The feature of the installation which makes it unique is that the entire unit is within the foundry building which has a ceiling height of only 18 ft 4 in. directly over the cupola. The close proximity of the cupola to the wooden frame building in which it is housed is evident in Fig. 1 which is a view of the cupola opposite the charging door. This proximity, coupled with the nearby presence of other university buildings demanded that the cupola not be permitted to extend above the roof of the foundry and that stack gases be cooled before being exhausted to the atmosphere.

### Combustion Conditions

Further complicating the problem is the manner in which the cupola is run. Despite the small size (18 in. diameter inside the lining), the cupola provides much more iron than can be used by most of the classes. Consequently, the stack is seldom fully charged even at the beginning of the run. Usually, only as much metal is charged as is necessary to pour molds made by that particular class.

Because the stack is never fully charged, combustion conditions are similar to the end of the heat of a normal operation. The lack of insulation of a stack full of charges being preheated is indicated by the temperature of stack gases (see table).

Prior to installation of this new bonnet all cooling was done by passing the stack gases through a large elbow (18-in ID) attached to the top of the cupola. This reversed the direction of the gases and sent them into a downcomer and thence through an exhaust fan shown in Fig. 2. Cooling is by eight brass garden hose nozzles inside the elbow and downcomer.

### Fire Hazard Licked

Despite the passage of a large (for our installation) volume of water through the elbow and downcomer, surface temperature of the elbow often ranged as high as 1200 F, producing a potential fire hazard to the foundry. After some study of the operating conditions, therefore, it was decided to design a new bonnet to provide more efficient cooling and more or less incidentally, to scrub the stack gases.

A sketch of the final design appears in Fig. 3, which is a cross-section through the newly installed unit looking at the furnace from a point opposite the charging door. Several features of the cooling system should be noted.

First, the cone mounted directly over the stack and the 3/4-in pipe ring which cools it are suspended from the walls of the bonnet and are removable as a unit for servicing by unfastening one pipe coupling. The 1/8-in. holes which create the cooling sprays are drilled at such angles that the entire upper surface of the cone is well covered with cooling water. The number of holes in the ring was governed by the desire to make the total hole area equal to the cross-sectional area of the ring pipe.

Second, to further insure that the cone receive sufficient cooling water, the overflow from the water pan surmounting the bonnet is directed upon the center of the cone. Water level in this pan, which is also removable for servicing, is maintained at 1½ in. to cool the upper surface of the bonnet. Although no temperature readings have been taken on this water during operation, at no time was the water more than warm to the touch.

Third, the 3/4-in. pipe ring welded to the outer walls of the bonnet also has 1/8-in. holes drilled so as to direct a continuous sheet of water down the side walls. Again, the total area of all holes was made equal to the cross-sectional area of the ring. Efficiency of the cooling is shown by the low surface temperature of the side walls of the bonnet during operation (see table).

### Slight Stack Vacuum

Fourth, further cooling of the exhaust gases is accomplished in the downcomer by the use of spray nozzles of the type used in agriculture for spraying plants in the field. Eight small, solid brass nozzles, each having a 1/32-in. orifice, are installed inside the downcomer in such a manner that the downcomer is filled with an extremely fine mist which possesses great cooling power.

A further unique feature of this cupola may be of interest, although this condition has been present since the furnace was first installed. During operation, the charging

**Fig. 1 (right) . . Closed, water cooled bonnet allows 18 in. ID cupola to operate under 18-ft ceiling of wooden building.**

**Fig. 2 (right) . . Water spray in downcomer adds to the cooling of stack gases. Water trap and exhaust fan complete system.**

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1. Brechtelsbauer, O. J., "Cupola Gas Scrubbers," AMERICAN FOUNDRYMAN, vol. 27, no. 2, Feb. 1955, pp. 34-37.
2. Anonymous, AMERICAN FOUNDRYMAN, vol. 17, no. 5, May 1950, p. 84.

door is closed by a close-fitting sheet steel door, making the cupola essentially a closed system from the blower to the exhaust fan except during actual addition of a charge. Because of the size of the exhaust fan used, even with the blower operating at maximum rate (560 cfm.), there is a slight vacuum within the cupola so that exhaust gases have no opportunity to leak out into the foundry. This is desirable from the standpoint of health of the students, as well as cleanliness of the foundry.

The efficiency of the new bonnet is shown by the values in the table and by the fact that the volume of cooling water used in the new unit is of the same order of magnitude as that used in the older unit. The values given are representative of the heats made thus far. The only necessary precaution is the adjustment of the proper water flow before turning on the blast to insure that water is covering the entire inner surface of the bonnet and the upper surface of the cone which bears the initial shock of the effluent stack gases.

It is believed that this is the only university installation of its kind. It has proven valuable by virtually eliminating the fire hazard of the cupola being housed in a wooden frame building. Its closed-operation characteristic is also attractive because of the improvement in foundry fume and dust control, thereby promoting health of personnel and cleanliness of the foundry as well as surrounding buildings. The possibility of research on material and energy balances in such a closed unit may be utilized at some future date.

**Cupola Bonnet Characteristics**

| | Start | Finish |
|---|---|---|
| Bonnet surface temperature | 60 F | 140 F |
| Temperature of exhaust gases at the charging door | 2250 F | 2550 F |
| Inlet water temperature (average) | 60 F | |
| Effluent water temperature from bonnet | 130 F | 140 F |
| Effluent water temperature from downcomer | 145 F | 155 F |
| Water used in bonnet | 20 gpm | |
| Water used in downcomer | 10 gpm | |

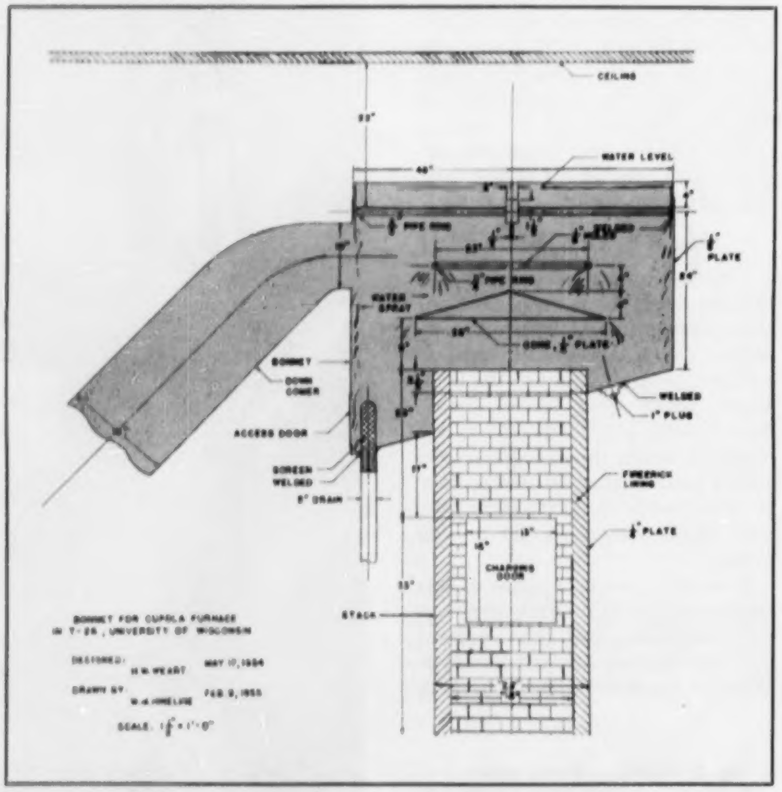



**Fig. 3 . . Efficient cooling of stack gases and incidental scrubbing is accomplished in this attractive university cupola bonnet at little cost.**

## *About the Cupola Bonnet • • •*

## AFS Air Pollution Control Committee Says

■ This article and description of equipment is a very interesting development by a university foundry laboratory to solve their specific problem.

It must be recognized that this cupola is operated at infrequent periods for short runs.

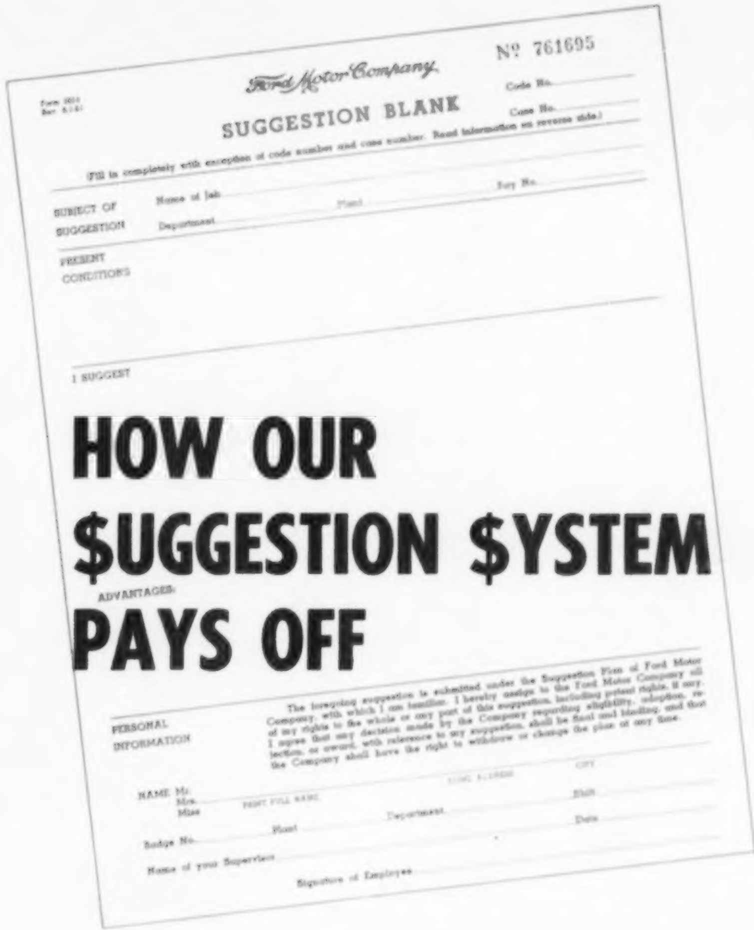
From a production foundry operator's standpoint, the following limitations should be noted:

1. There is no vent to the atmosphere in case of a mechanical failure of the fan.
2. There is no relief arrangement on the bonnet to provide for exhaust in case of an explosion caused by carbon monoxide gas.
3. The use of spray nozzles might cause and present a maintenance problem.
4. It is generally recognized when fan equipment is required to remove hot cupola gases that the addition of an efficient collector at the discharge point is a comparatively small item.
5. There is no provision in this installation for segregating collected solids by settling or otherwise for a possible reuse of water.

## Weart Responds

1. As pointed out in the article, the charging door may be closed during blast-on periods, but if left open would provide the necessary atmospheric vent. Furthermore, the upper water pan merely rests on supports within the stack so that it can be easily removed and melting can then proceed with the stack open directly to atmosphere.
2. The upper water pan with the center overflow provides our installation with its explosion relief arrangement. The pan sets loosely on the upper water spray ring and would be blown upward in event of a carbon monoxide explosion, thereby releasing the pressure very effectively.
3. Spray nozzles admittedly would present a problem if they were used in the region where the stack gases first entered the bonnet. In our installation, however, the spray nozzles are used only for final cooling to protect the exhaust fan bearings and not therefore subjected to the stack gases until they have been cooled considerably. As indicated by the sketch of the bonnet, the initial cooling is accomplished by water sprays issuing from 1/8-in. holes drilled in a 3/4-in. pipe. Clogging is not anticipated and, should it occur, cleaning of the holes is a fast and simple operation.
4. By a collector at the discharge point, it is assumed that reference is being made to removal of solids from the gases before exhausting them to the atmosphere. We have made no studies of the weight of solids present in the final discharge gases, as this is not a problem in our application.
5. The re-use of water would undoubtedly improve the economy of the installation, but as the Committee points out, the cupola is operated rather infrequently for short periods. For this reason it was felt that the initial cost of a water recirculating system could not be justified.

A settling basin exists in on our installation immediately ahead of the exhaust fan. It has proved quite efficient in removing solids from the cooling water used in or drawn into the downcomer. Reference to this portion of the exhaust system was purposely omitted because it was not considered to be an unusual feature of our installation.




# HOW OUR $UGGESTION $YSTEM PAYS OFF

John W. Schneider / *Manager*
*Dearborn Iron Foundry*
*Ford Motor Co., Dearborn, Mich.*

**Management interest and participation is a key factor in Ford Motor Company's suggestion plan**

■ As a part of the Ford Motor Company expansion program, early in 1950 we were asked to set up a new foundry—in which we would cast crankshafts, camshafts, and valves for the Ford, Mercury, and Lincoln engines.

Two new processes were to be used in the castings, both new to large-scale production. First, shell molding would be used rather than the conventional method of sand casting. Second, nodular iron would be used in the crankshafts.

▪ **Our Employee Suggestion Plan** had been functioning in other locations throughout the Ford Motor Company since 1947. Now we had an opportunity to analyze its chances for success in our new operation before we installed it. We were well aware that such a program provided a key to greater productivity. Our immediate concern was how to use this key to its greatest advantage.

As a result of our study in other locations we knew that the cooperation and participation of top management in the plant was a necessity. This meant that our Suggestion Committee—the men who arrived at the yes or no answers—must be represented by key men in all phases of our plant activity.

### Suggestion System Personnel

Consequently, our committee appointees consisted of the manufacturing and plant engineering manager, quality control manager, production control manager, plant controller, suggestion programs coordinator and myself. During my infrequent absences our production manager acts as co-chairman. Usually, however, we are both present. Each of these members considers it an important part of his work to be a part of this committee. His time, resources, and unfailing interest are always available for this purpose.

The important role played by the suggestion personnel who investigate and coordinate the program received top consideration. We required and got men who had the qualities necessary to put the program over. Most important of these characteristics were the right personality, thorough knowledge of our operations, and a manner of gaining the respect and confidence of the employees.

It was my feeling that a number of areas of the program should have my individual support. The first of these was the personal interest that I felt a plant manager should exhibit. The interest of others will be a reflection of that shown by the manager.

This top level interest *cannot* be of the on again, off again variety displayed only at special promotion times. Continuing interest is the answer.

One form of the committee's interest can be exhibited in attendance at the meetings. We have alternate members but the regular members must attend these meetings except in extenuating circumstances.

The suggestion programs are always included on the agenda of my weekly staff meetings.

The Training Section conference leader weaves the suggestion program theme into nearly every weekly personnel development meeting which all members of management attend.

In these meetings, the benefits of the programs are pointed out to supervision from the standpoint of better and more efficient operation, quality, safety, and better relations with our employees.

▪ **Management Proposal Plan.** We have informed our supervision that participation in their own management proposal plan is one of the most tangible means of evaluating their performance. Also, a management proposal is written indication of thinking on the job.

We have found that in those departments where the participation is high in the management proposal plan it is also high in the employee suggestion plan. We have found that departments that give the proper attention to such programs as suggestions, safety, quality, etc., also reflect a high efficiency rating.

### Late Shift Arrangements

The suggestion coordinator frequently attends meetings with the afternoon and midnight shift supervisors to answer their questions and keep them posted on suggestion activity. These meetings are necessary to hold the interest of the supervisors on the late shifts and prevent them from having a feeling of being left out.

▪ **Why the Program Clicks.** As everyone in suggestion programs must realize, we know that prompt processing of suggestions is one of the most important parts of the whole job. That's why our record of handling suggestions has played such an important part in the success of our program.

Our average processing time on all types of suggestions is one and a half months.

All cases are reviewed in the order received. An agenda is distributed four days prior to the meeting, allowing the committee members time to prepare themselves so that cases do not have to be referred for more information.

Our maintenance superintendent keeps a record of all cases to

**Plant modernization** made sharp turning mechanism on hopper cars obsolete; suggestion to eliminate parts and maintenance brought award.

**Cutting vents in the hot slag chute** to eliminate the accumulation of gas which would cause an explosion, was cupola tender's profitable idea.

**Operator injury was averted** by simply adding sufficient counter weight to the light side of this foundry roll-over tractor block inspection gauge.

be put into effect. This book is brought up to date weekly at a meeting with the suggestion unit personnel. We place much emphasis on putting the ideas into effect after they have been approved for trial by the committee. We realize that there is nothing that will dampen a suggester's spirit more than having an idea termed worthy *but not* put into use.

Awards range from $20 to a maximum of $3000 and fall into two general types:

*Calculable Suggestions* — When the suggestion results in a direct calculable saving to the company in materials and or labor costs, the award is equal to the estimated savings for the first two months, or one-sixth of a year, whichever is greater.

*Non-Calculable Suggestions* — Awards for suggestions of intangible or non-calculable benefit are commensurate with the benefits to be derived as judged by the Suggestion Plan Committee.

At the outset we could see that claims of prior consideration by members of management could result in a serious problem unless the committee adopted some ground rules on this matter. It was decided that all claims of prior consideration must be supported by prior action in writing. We have experienced little difficulty since we adopted this policy.

### Publicize Awardees

While publicizing awards in the employee newspaper is valuable, the newspaper is interested primarily in large award winners.

In addition to the newspaper, we take one or two photographs per month and display them on our suggestion boxes. These pictures include earners of both large and small awards. We feel this has been helpful in promoting participation with minor suggestions.

We have an annual Award and Commendation Club dinner for those employees who have received at least 10 awards for suggestions or 10 letters of commendation for management proposals since the start of the suggestion programs.

There is no doubt that employee suggestions have resulted in a great many safety improvements as well. The largest safety award in the Ford Motor Company to date w[as] paid by the Dearborn Special[ty] Foundry just a few months ago. L[et] me quote the statement of our Pr[o]duction Manager when he presen[t]ed the employee with a check f[or] $400:

"It has been said that suggestion[s] often result in the elimination [of] men. I am sure that no one will d[e]bate the fact that this suggestio[n] will prevent the complete elimin[a]tion of one or more of our emplo[y]ees by correcting a hazard th[at] could result in a fatal accident."

The committee has two oblig[a]tions to our employees in regard [to] the suggestion programs.

First, it is our job to provide a[n] opportunity for these people to ex[]press their ideas. Secondly, it is ou[r] job to maintain their confidence i[n] our ability to evaluate them

▪ **Success of Program.** The employ[]ees in the foundry have submitte[d] more than 5000 acceptable idea[s] since the plan was made availabl[e] to them three years ago. Twent[y]-seven per cent or approximatel[y] 1350 of the first 5000 ideas hav[e] been adopted. The average awar[d] since the start of the plan is $75.9[]

The success of our managemen[t] proposal plan has been equall[y] gratifying. In the 33 months it ha[s] been in effect in our plant, we hav[e] averaged more than one suggestio[n] per man each month.

Helping to make this figure s[o] impressive were several outstand[]ing months when our rate of par[]ticipation rose to 212, 234, and 24[] per cent.

Our adoption rate is 30 per cent. Helping us to attain these figure[s] are several outstanding partici[]pants—one in particular has aver[]aged six management proposals pe[r] month for the past 30 months.

Our experiences in a productio[n] plant leave no doubt in our mind[s] that the ideas of men and women when translated into increased pro[]duction and safer operating meth[]ods, can result only in higher stand[]ards of living and more jobs fo[r] everyone.

I think there are many reason[s] for the degree of success that w[e] have attained—but the greatest con[]tribution, I believe, is the cooper[]ation and enthusiasm displayed b[y] every member of our team.

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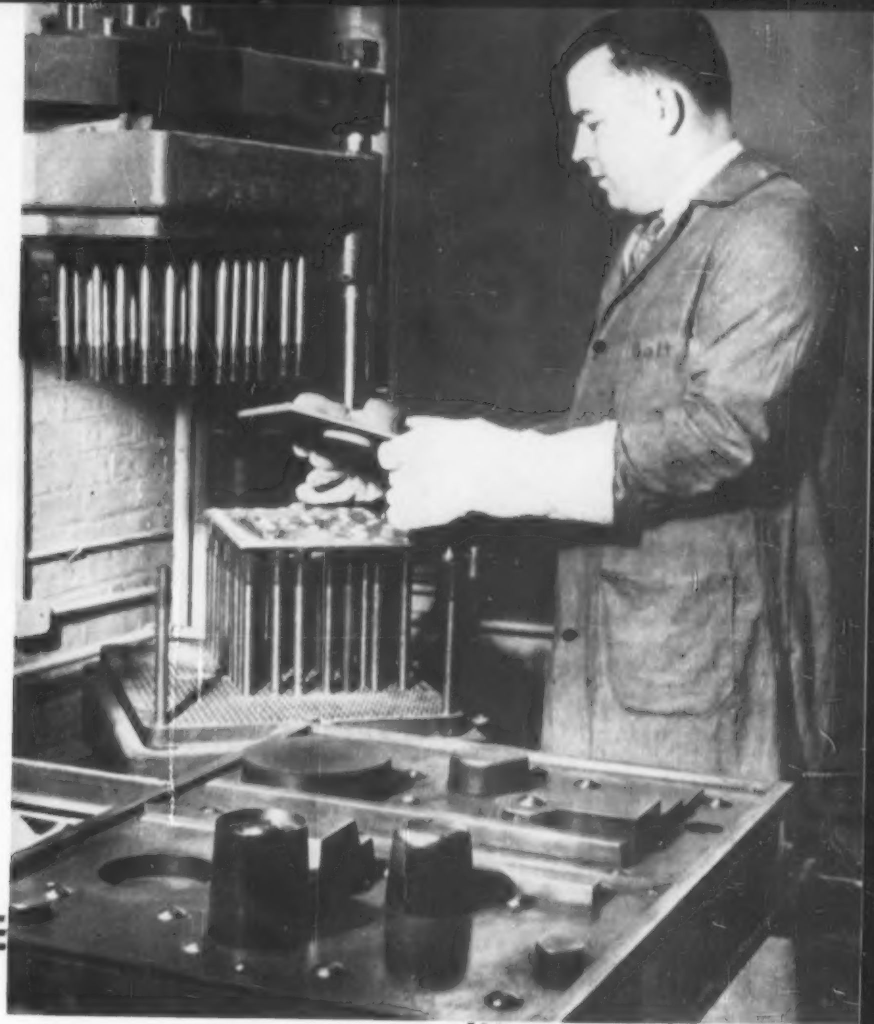

# SHELL MOLDING IDEAS for the Practical Foundryman

A MODERN CASTINGS BONUS

You can put these ideas on shell mold casting to work in the shop every day

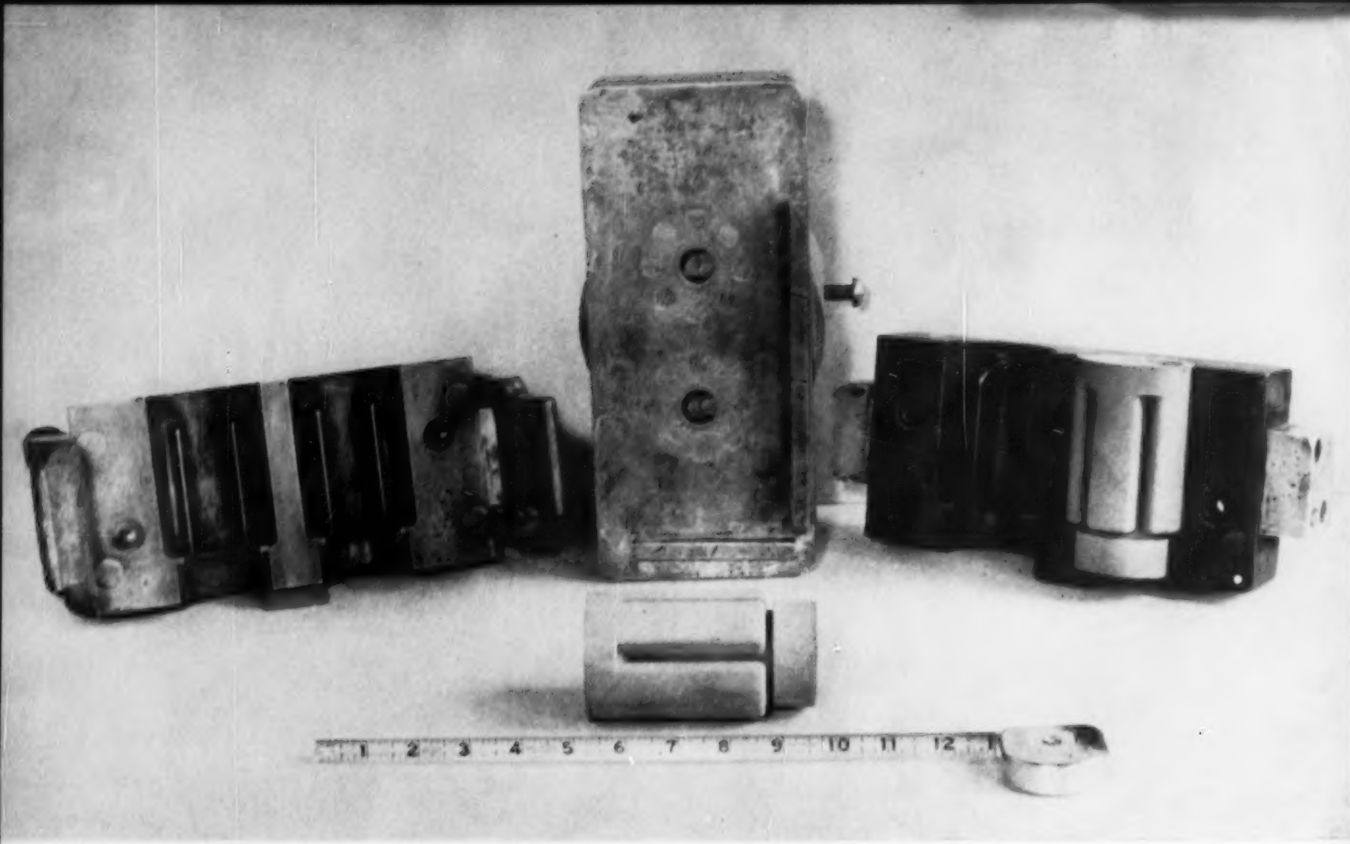


Fig. 1 . . Simple shell cores can be blown with bench blower. Note slit rubber valves in blowholes.

# PRACTICAL TIPS on Shell Molding

## Pioneering Lynchburg Foundry Co. has learned a lot in setting up its new shell molding foundry

G. P. DERBY/*Foundry Engineer**
Lynchburg Foundry Co.
Lynchburg, Va.

■ Everyone in foundries using the shell molding process has been faced with the common problems of making the shell mold, assembling it, and of making use of it after he has it. Some have chosen different paths in solving these problems.

In developing our shell molding project at the Lynchburg Foundry over the past several years, we have learned a great deal in working out our problems.

Our first experimental work was designing a shell molding machine. When we began most shell molding programs were in their infancy and building your own rig was the accepted means of getting started.

Our first attempt was a four-station, multiple pattern, turntable machine. It was to be the proving ground for the ideas later incorporated in our four- and six-station production machines. The turntable idea, the shell curing devices, the stripping mechanism and the rotary drive were all first tried on this machine. In addition, all of our experimental work on the sand application problem was carried out by hand-operated devices on this equipment.

Early in the spring of 1952, we had successfully blown shell molds using conventional core blowing equipment in conjunction with special blow heads. The ideas were much the same as those used in some of the present blowing equipment commercially available. Blowing was accomplished through a grid of blow tubes and vented back through the head. The head was operated cold. 20 psi air pressure was used along with normal dry resin and sand mixtures.

Included also in the early devices were attempts with roll-over

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dump boxes coordinated with a jolting action or a vibrating rig. Cores have been made with conventional dump boxes and with various blowing equipment. Good results have been obtained with a simple bench cartridge type core blowing machine using a hot cast iron box and coated sand (Fig. 1).

Soon after the completion of our first machines, a program was established to evaluate various materials used and actually test the capabilities of the process. Which should we work on first . . . the sands or the resins? In actual practice we worked on both simultaneously.

Generally, we found during our early experimental work that the majority of the resins we tested did the job that was anticipated. Today we find even more consistent results and we have established a medium cure two-stage resin as a working standard. Using this resin we have performed a large percentage of our experiments on sands and sand application.

We have not attempted thus far in our production work to vary from fast, to medium, to slow curing resins other than when the circumstances dictated it. Our main variation has been in going to slower curing resins on intricate patterns to obtain longer flow characteristics. Our primary lab test for a resin has been a shop application run on a production basis. We do, however, make conventional lab tests, including tensile and permeability tests.

The practice of using standard mixes in the dump type core box has usually been more successful while using a slower cure resin. This has been particularly true in cases in which it is necessary to drop sand into deep narrow holes and passages (Fig. 2). We have used caution in attempting to dump invest a core box with undercuts as we have experienced considerable difficulty in obtaining a sound core in these areas. A core box necessitating the filling of sand under a ledge is usually better blown with a coated sand.

We found by trial and error that one resin will give slightly better dimensional stability while pouring the mold and correspondingly better casting results. This has primarily proved effective in cases where castings were on the border line for dimensional considerations.

The sand mulling was originally underestimated in the cycle. It has been our experience that it is necessary to mull the sand 10 to 15 minutes—actual casting surface tests of a qualitative nature demonstrated this to us. Our mixing equipment is of conventional foundry design. All sands and resins in the shop are conveyed to the mill by pneumatic conveyor equipment. The sand and resins are batched together directly after the sand is

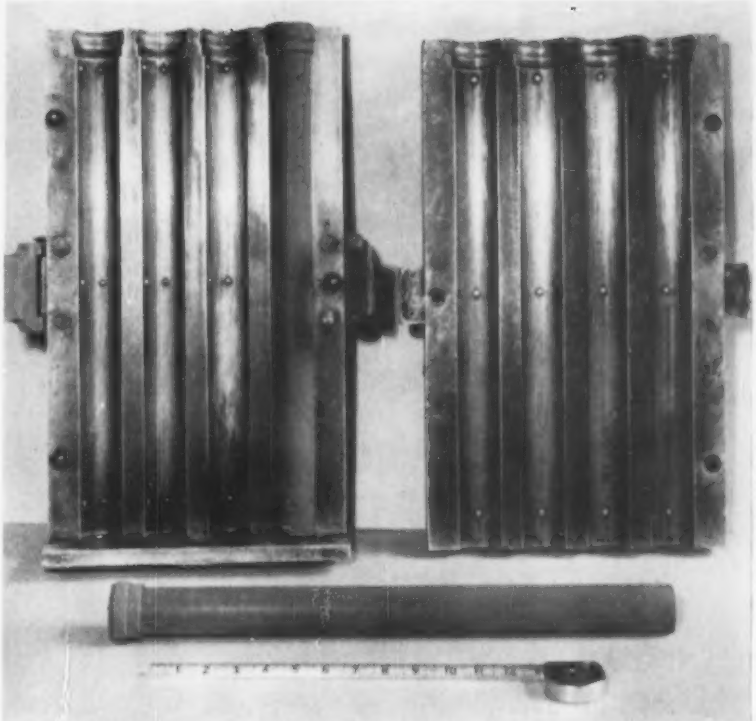


**Fig. 2 . . Slow-cure resins work better in deep dump-type core boxes.**

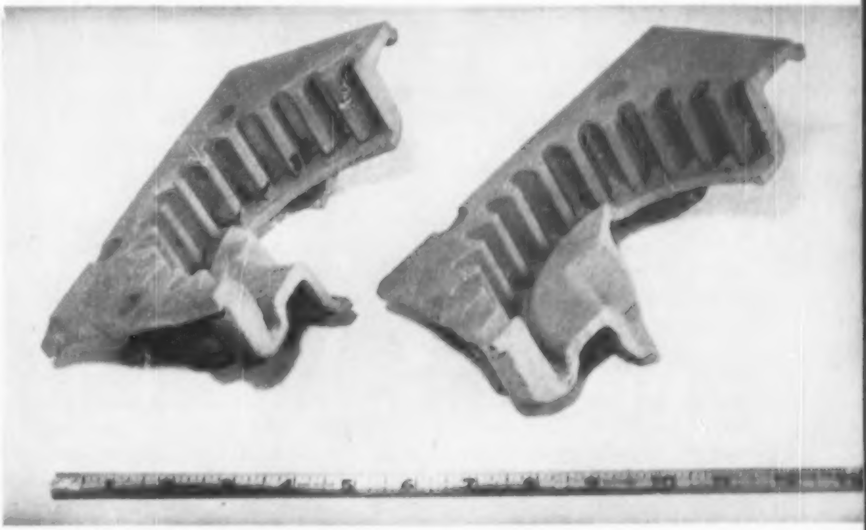
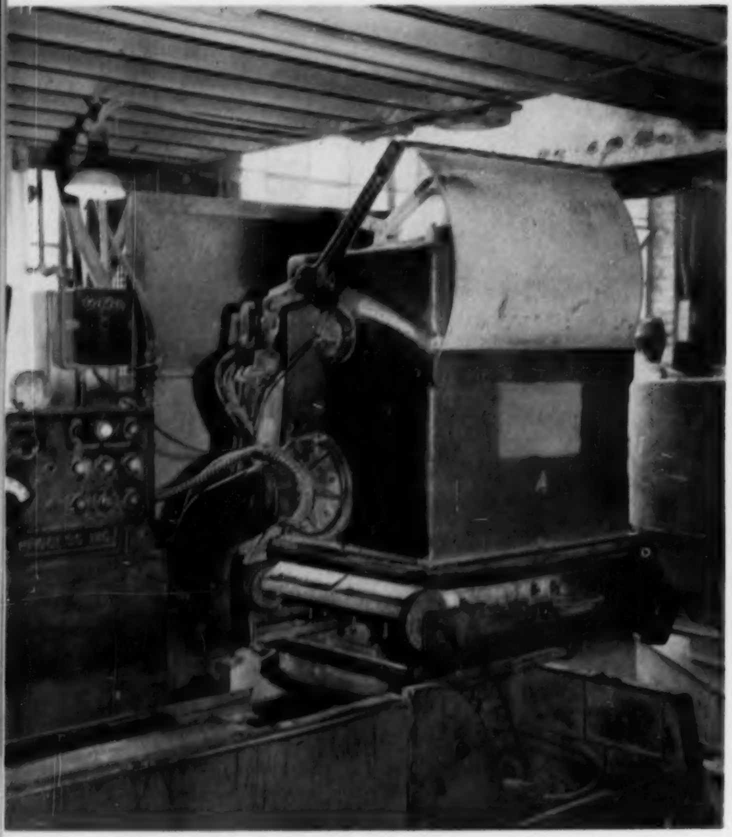


**Fig. 3 . . More forceful application of sand-resin mix can lead to more rather than fewer voids in vertical walls of shell molds (left).**



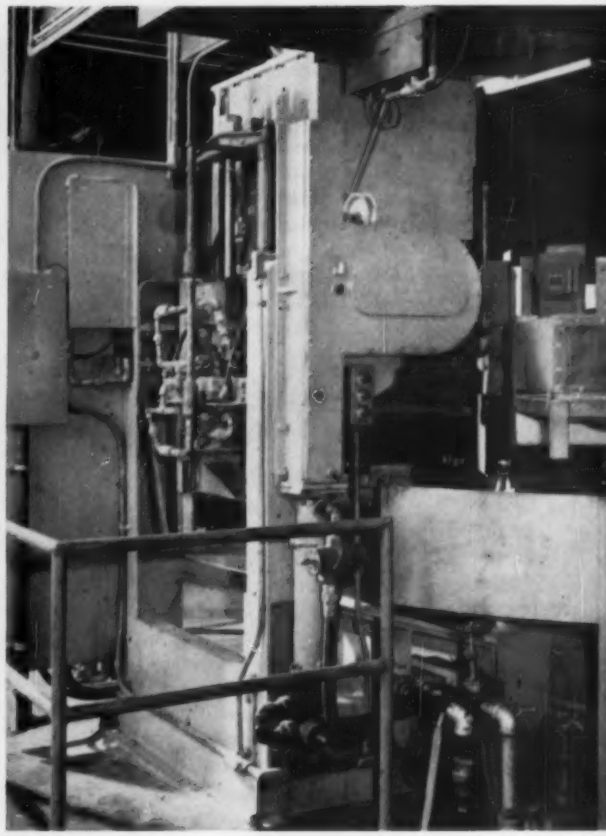


**Fig. 4 . . Sand application characteristics of progressive machine (left) and "all-at-once" machine differ.**

discharged from the sand silo. They are blown to the muller one batch at a time. The keeping of the sand and resin in batches eliminates the possibility of segregation.

In conjunction with conventional resin examinations we have been working for some while on the coated sands. Early attempts included varnishes, resins in solution, and various special preparations. Our most successful results of late, for uses in core blowing, have been those obtained with what we refer to as the completely coated sands. There is no powdered resin free in this mix nor is the mixture dependent on a binder or wetting agent to affix the resin to the sand.

Samples of various sands from all parts of the country have been tested. The sand we feel has been the most suitable for our use has usually been found to be a six screen sand, and to have a maximum of 6 per cent pan material. An AFS 120-130 fineness classification has, in all cases, been sufficiently fine to produce the casting finishes we desired. All castings are shot blasted with a number 170 shot during the cleaning operation.

A dry clay-free sand is a prerequisite. Additives have been incorporated in a number of our mixes but we have discontinued their use because our work did not indicate an appreciable change in the quality of gray iron castings.

There has been considerable mention of round grain sands vs. angular sand in respect to resin economy and strength of the mold. On one shop problem the most evident characteristic to distinguish the two has been in the flowability of the two sands. In our application we have found the sub-angular to round grain sands to have a more suitable flowability as evidenced in our shell making operation. The ability of one sand vs. another in respect to flowabilities may very well be evident in the quality of a difficult investment job and in the analysis of cost in the cleaning room.

We watch the slump angle of our mixtures as they are in use. On work of medium requirements all three types of sands should perform equally well. It is assumed that the sands have about the same screen distribution.

Sand application has received considerable attention in our shop. Perhaps we found it necessary to work on this angle early in our experimentation due to the relatively complex problems we encountered on several of our initial jobs.

After special tests have been made to determine the best selection of sand and resin for a particular need, there is still the problem of properly investing the pattern to obtain a quality shell. In all systems relying on gravity as the major force in applying the sand there is the problem of getting the highest uniform density obtainable in the mold for the mixture being used.

Vertical walls of a relatively uniform density, free from voids, have always presented a problem to us. Whether using a rollover dump,

sliding gate, or a louvered system type of applicator, the fact remains that the horizontal surfaces of the pattern get the greatest ram effect from the sand. Further, after the sand is in contact with the pattern, the weight vector of the sand is primarily directed towards the horizontal surfaces. In contrast, the vertical walls of a pattern are struck at an angle at best and usually the action is a sliding effect with rapid filling about them.

Fortunately, the results obtained in the shell usually are not as drastic as this comparison might indicate; however, there normally is a difference in the two surfaces of a shell. One might picture that in investing a gear pattern, for example, the teeth would be in this area of least effective molding.

We have not found that the most forceful means or most rapid application has always given us the best results. By rolling a dump box faster, or opening a louver or slide more rapidly intending a more forceful application, the results have usually been the appearance of voids in the shell (Fig. 3) which produce knots or globs of metal on the very casting surfaces we have wished to improve. Therefore, there must be a balance or compromise between the two considerations to get the maximum ram without obtaining voids. We slow the application when the voids appear.

We have noticed in our equipment that there is at times a very delicate balance in adjusting the rate of application and it must be duplicated mechanically. Each type of applicator we have studied (Fig. 4) has had a given set of characteristics and it is extremely important to recognize them to obtain maximum results.

The sand in an applicator will follow a generally similar trajectory when operated within reasonable limits. Study this trajectory and be able to anticipate its effect on the shell. It will help in the arrangement of patterns on new jobs and may be used to advantage in the improvement of present work. This makes an additional factor to be considered along with the gating layout, when designing a new pattern plate arrangement. It is important to take advantage of any effect that might improve the conditions on vertical surfaces.

Another condition observed in the applicator was the extreme turbulence as the sand and resin descended to the pattern. It was obvious that a segregation condition existed. Until a glass applicator frame was tried, however, it did not seem possible that the agitation could be as drastic as it was. The counter flow of air being displaced as the sand fell produced a condition not unlike discharging an air hose in a barrel of resin.

Any method you may devise to alleviate this condition and by-pass this displaced air to the top of the applicator will appreciably improve the quality of the mold (Fig. 5). Drilling very small holes at the bottom of an applicator box at an acute angle to the downward flow of the sand has proved a simple but effective means of venting in some cases.

A fourth molding consideration might well be added to the sand, resin, and application factors, pattern temperatures, and cure. We are presently very much concerned with the right temperature level. A reversal of our production outlook of turn up the heat and cut the cycle is rapidly taking place. Without stating specific operating conditions we definitely feel that lower pattern and oven temperature which still fit the job will help the surface qualities of any casting. The lowering of pattern and oven cure temperatures has also noticeably affected casting dimensional qualities favorably.

The problem of assembling shell molds has been a major problem since the beinning of the work at our shop. We have found very effective the method of applying a powdered phenol resin to the parting of the hot shell through a grid plate and then applying pressure

**Fig. 5** . . Slotted rubber baffles in applicator exhaust displaced air.

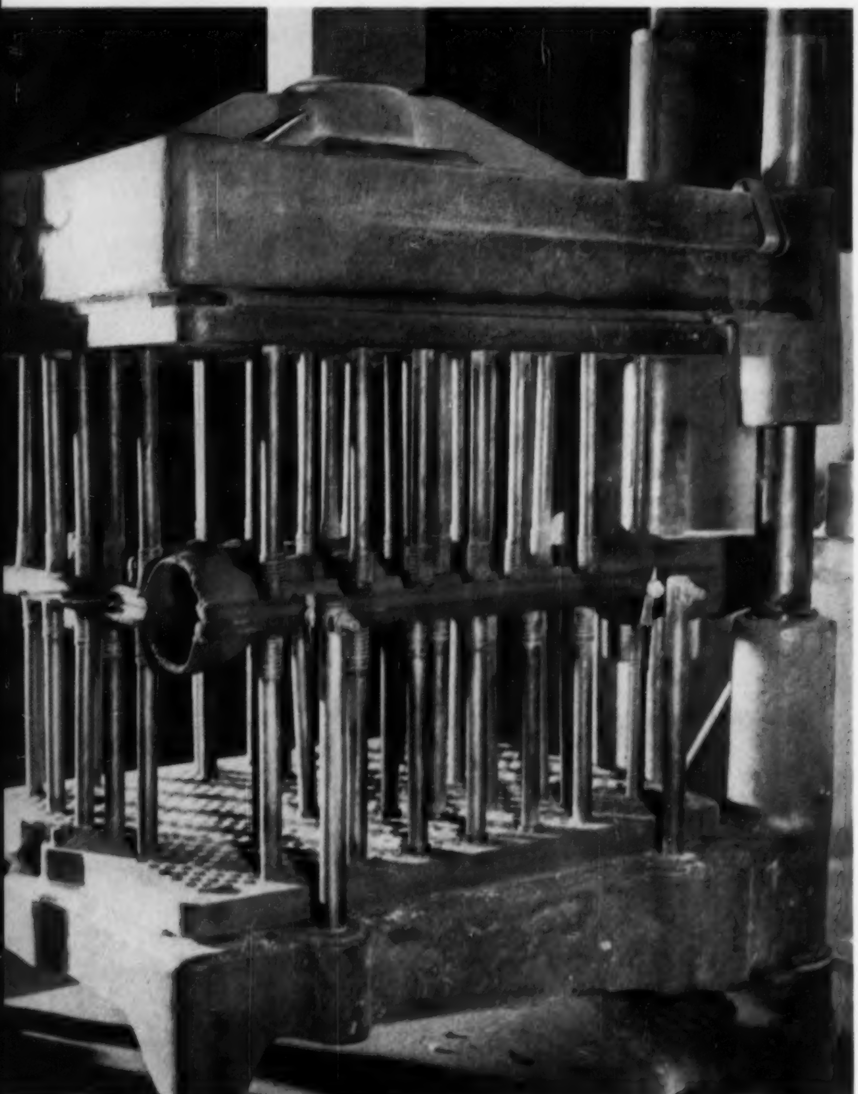


**Fig. 6 . . Glued mold is deilberately warped by washers under center pins.**

to the two halves by spring-loaded pins in a press arrangement. Thus far it has been successful in binding the shells in a plane condition.

At times it is difficult to apply the powdered resin to a given area without getting it into the mold cavity. The impression of the powdered phenolic resin will be produced in the casting. In these cases we have applied a polyvinyl acetate resin to the area. This glue may be applied to the shell with a conventional glue bulb and slopping some into the mold is of no consequence since it vaporizes under the heat of the molten metal, leaving no traces. This glue may also be quite useful in pasting cores in a hot mold.

The spring-loaded press has also been useful in performing what might be termed a secondary faking operation. On several occasions we have found it actually advantageous to warp a shell while in a hot state to compensate for a given casting warpage characteristic (Fig. 6). This has been accomplished by applying greater spring pressures in one area than in another.

The question of back-up of a shell mold has always been of vital interest. There are many advantages to every system and here again the everyday class of work will determine the system chosen. The foundry interested in small casting and thin section work may well find the horizontal pour with relatively no back-up most advantageous. Surface finish, yield, and dimensional control seem to be slightly better for this class of work.

As the size of work increases, however, other problems of mold stability, crack, and actual runouts may well offset the advantages. Further, in alloy metals requiring larger riser sections for feeding, difficulty may be experienced in obtaining molds capable of not burning out until metal solidification.

So it is not always just the casting that must be considered. We in the jobbing foundry industry must be ready to pour all extremes of work. Thus far in shell we have poured jobs ranging from 2 ounces to 200 pounds and we must be able to handle this work simultaneously without special rigging and on a relatively high production basis. Only shot would give us this versatility. The shot used is a 990 shot.

The vertical pouring system has its dimensional and yield problems; however, our latest experimental gating projects have looked most promising. Using extremely small gating components and pop gating, yields up to 80 per cent have been obtained and have been accompanied by a decrease in required dimensional tolerances (Fig. 7).

### What Are the Tolerances?

A discussion of shell molding would hardly be complete without mention of tolerance and what might be expected from a shell casting. The jobs we have made in shell work may fall into three general categories: those requiring surface finishes we were unable to obtain in our green sand; those castings already in use in an as-cast state in green sand that may be generally improved in shell; and those castings which we look to reduce machining finishes or actually eliminate machining work. The latter group causes the most controversy.

In working with shell we have usually found that a ± 0.0025 to 0.003 in. per in. tolerance would apply to a single given dimension.

Further, we have found that generally 0.010 to 0.015 in. allowance for a parting is sufficient and practical in everyday shop work. These two sets of figures are valueless however, to apply as bare fact to a casting being considered in shell without following through with all of the factors to be taken into account. At present we receive frequent inquiries accompanied by shell casting drawings on which it is obvious these tolerances have been applied. They often cannot be met. The important questions to be answered when considering a casting for shell molding are not answerable with the application of these two generally accepted rules of thumb.

How flat can a surface be held? To what degree can two surfaces be held parallel? How concentric will two diameters be? What concentricity can be expected from a bolt hole circle and a center bore? What out-of-roundness may be expected? How straight will a shaft be? What total indicator reading may be expected on a given surface? All of these questions might reasonably be asked of one casting.

Assuming that the tolerances quoted to a customer are satisfactory, two further questions might readily arise. Will the complete range of tolerances be found in each casting or will the variation in one casting be relatively small and the extremes be found only in different castings?

Further, the problem of dimensional control in the foundry is only one phase of the problem of obtaining a successful end product. In working with finish in thousandths, a close liaison between the machine shop and foundry must be maintained. The method by which a casting is to be machined may often set the limit of finish.

### Treat Each Casting Alone

We have had two jobs that were, for practical consideration, identical—0.015 finish to be ground. The dimensional control on one casting was many times as stringent as the other due to the method of grinding employed. Similar crankshaft jobs have been made, one with three times as much finish as the other due to the method of machining and chucking—one shaft being centerless ground, and the other being chucked on one end, then centered and turned. It is essential that the method of machining minimum finish work be taken into account.

We do not feel that a given set of rules can be drafted to apply reasonably to these questions. This brings the discussion of shell tolerances back to this—each casting must stand on its own merit. Experience and the correlation of statistical data in the future may well afford the answers. For the present, the application of good foundry logic and an analytical approach to each individual job will produce gratifying results.

It would be well to summarize a few of the points we have attempted to present. Briefly they are as follows:

- In general we have found the resins used performed the job anticipated.
- It has not been necessary for us to use special additives and procedures to obtain the results we have wished in our sand practices.
- Sand application has played a very important part in the studies performed. Study the characteristics of your machine. Study in detail the curing problem as it presents itself in your shop. Fit your pouring method to your need, not on generalization.
- Study each casting for dimensional merits and consider it individually.
- And last, close cooperation between the foundry and the machine shop is a must as a prerequisite to successful use of minimum finish allowances.

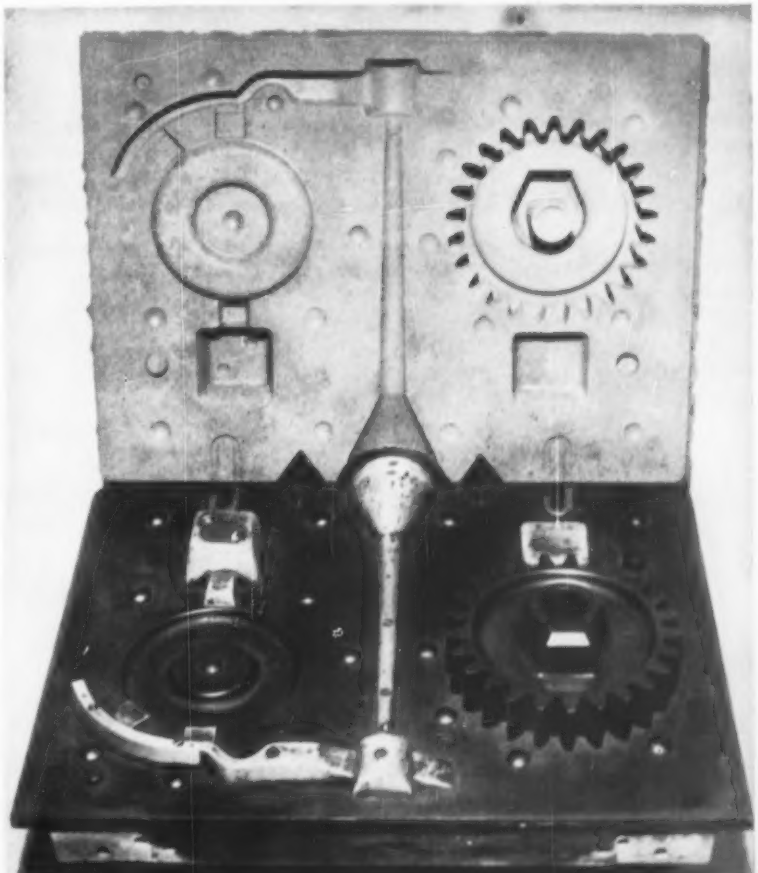


**Fig. 7 . . Conventional pattern and gating rig. Figure 3 shows shell.**

# 59 ANSWERS

## to your Shell Molding Problems

■ The secrecy formerly surrounding shell molding operations is gradually disappearing. Now that discussion and interchange of ideas is becoming more frequent, many foundrymen who previously operated virtually under lock and key are discovering that their "unique" problems are shared by many others.

Long promoted by the Amercan Foundrymen's Society in all fields of foundry endeavor, and enjoyed widely in other areas of activity, the practice of a free exchange of experience and techniques is beginning to catch hold in shell molding.

With this spirit in mind, the following "probable solutions" are offered to indicate corrective measures which worked under a given set of conditions.

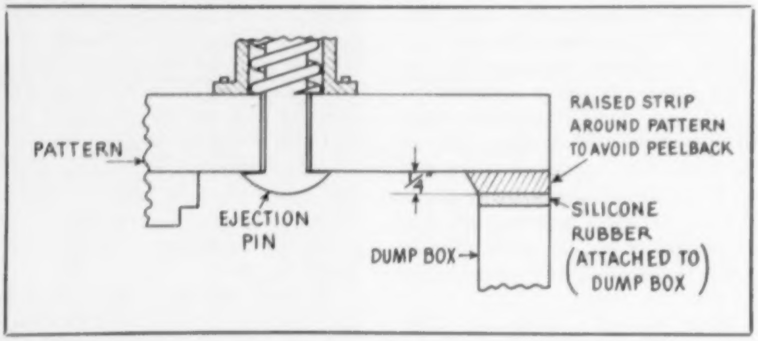



**Fig. 1 . . Peeling can be avoided by raised strip on pattern or frame.**

Shell defects are listed by categories with a brief discussion following the probable solution where applicable.

#### Peeling or Drop-Off

*Peeling* is the falling away from the inverted pattern of the uncured shell, usually intact and in localized areas.

*Drop-off* is the falling away of a secondary layer of the shell, partly softened, leaving a thin and partly cured layer next to the inverted pattern. These defects are most commonly associated with resin properties and while fairly common in the early days of shell molding are not encountered to the same frequency at present.

**Fig. 2 . . Shells break when they adhere excessively to the pattern.**

#### Probable Solution

1. *Improved pattern-dumpbox seal.* The addition of a raised strip around the outside of the pattern separates the shell build-up from the dumpbox, thus eliminating a pulling away of the shell by the dumpbox when the pattern is lifted off. This raised strip may be attached to the pattern or may be a part of the pattern frame (Fig. 1).

2. *Use resin with higher viscosity or use less resin.* The uncured shell in the inverted position depends on the viscosity of the molten resin to hold it onto the pattern. Where conditions of production necessitate the use of thin resin to speed build-up rate, a smaller percentage of resin is advantageous. If permissible, a thicker resin will work better.

3. *Reduce dwell time, making thinner shells.* Thinner shells mean less weight hanging in the inverted position.

4. *Use sand with lower clay or*

*moisture*. The presence of such materials in the sand reduces shell strength.

5. *For peelback, use higher pattern temperature.* The increased temperature of the pattern will advance resin curing, thus increasing viscosity.

6. *For drop-off, use lower pattern temperature.* A lower pattern temperature will effectively reduce the build-up thickness and give a more uniform cure throughout the shell cross section.

7. *Tighten ejection pin springs.* The weight of an ejection pin hanging downward onto the shell in the inverted position is often sufficient to start peelback.

### Sticking or Binding of Shells

1. *Check pattern for undercuts or rough spots.*

2. *Condition a new pattern thoroughly.* The proper conditioning of a new pattern is essential. When using silicone release agents it is necessary to provide a film of conditioned release agent before starting shell making.[1]

3. *Polish and recondition abraded pattern.*

4. *Chose proper lubricant.* Silicones, both emulsion and fluid types, as well as certain waxes, are commonly used—normally, waxes are restricted to low temperature operations (Fig. 2).

5. *Avoid excessive lubrication.* The use of excessive lubricant can result in the build-up of a gummy residue to which grains of sand will adhere, thus making release difficult. This condition results in a poor surface finish of the casting. Frequent applications of a dilute solution in a fine spray normally works best.

6. *Clean pattern periodically.* Many foundries have found it advisable to clean the pattern after each shift. This may be done by solvents, or by placing the pattern in the oven approximately 15 minutes and then brushing with a fibre or brass brush. (The latter is not advisable with aluminum patterns.) A generous spraying of release before preheating then prepares the pattern for subsquent operation.

7. *Use a slower curing resin.* In the curing of a phenolic resin, some shrinkage occurs which can cause binding, particularly on deep draw or minimum draft applications. In these cases, some slight flexibility in the shell at ejection is desirable. Experience indicates that slower curing resins perform better than rapid cure resins under such conditions.

**Fig. 3 . . Puffs of resin on shell are caused by poor mixing practice.**

8. *Check level of ejection pin platen.* Uneven lifting of the shell can cause binding on vertical surfaces, particularly on deep draw or minimum draft applications.

9. *Check for loose pattern pieces.* All pattern pieces must be rigidly attached to the pattern plate.

### Warped Shells

1. *Check for warped pattern.* A flat pattern is essential.

2. *Lengthen cure time.* For a perfectly flat unwarped shell it is essential that no rubberiness exist at ejection and that the resin be fully cured. The correct cure time for any job may be determined easily by trial. If shells are not bonded immediately they should be cooled on a flat surface so as not to induce warping.

3. *Avoid excessive oven-pattern temperature differences.* Warpage can be caused by the difference in cure rates of the relatively hot oven side of the shell as compared with the relatively cold pattern side of the shell.

### Poorly Filled or Imperfect Shells

1. *Use a dry mix.* Moisture retards filling during investment.

2. *Improve mixing practice.* Good distribution of resin and sand is essential both for adequate strength and for a homogeneous mix. One indication of poor mixing is the appearance of resin puffs on the shell surface, as illustrated in Fig. 3.

3. *If the shell has low density areas, use a higher melting resin or lower the pattern temperature.* It is essential that there be sufficient time after the resin begins to soften to allow a good fill of the mix around the pattern before cure advances to the state where the mix will no longer flow. Higher melting resin or lower pattern temperature will allow this time for the mix to fully reproduce the pattern contour before the resin begins to cure. Fig. 4 shows a poorly filled vertical surface caused by excessive pattern temperature.

4. *If streaky, turn dumpbox fast-*

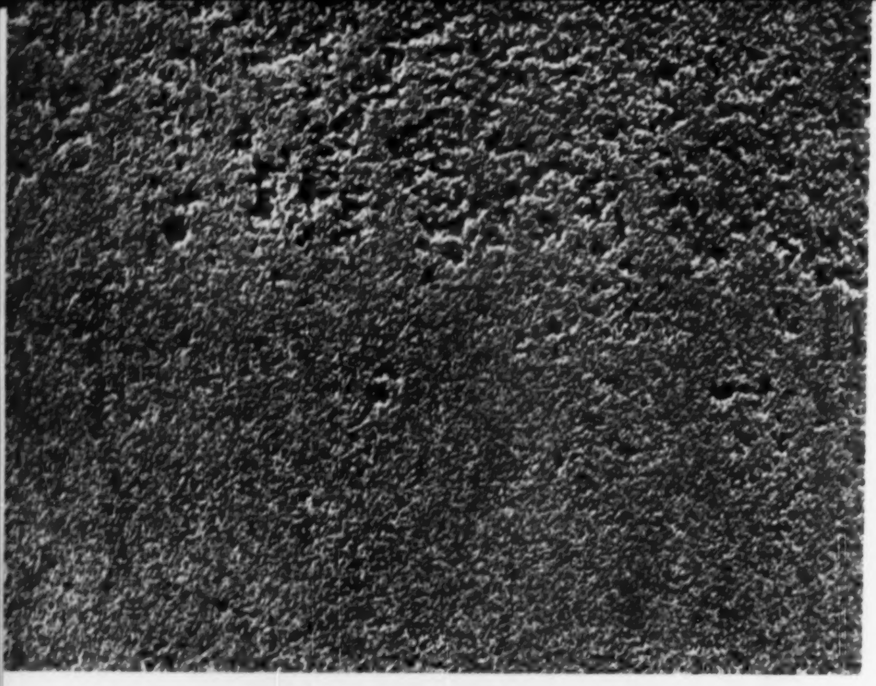


**Fig. 4 . . Depressions in low density area of vertical shell surface are result of excessive pattern temperature. Higher melting resin might help.**

*er or add louvers inside the dumpbox.* A slow sliding action across the pattern is undesirable and often results in a "shadow effect" of poor filling on the surface away from the direction of flow. Conversely, turning the dumpbox too fast promotes entrapped air.

5. *Use a vibrator while investing.* To eliminate entrapped air and to increase density, this technique is especially useful where small cavities in the pattern must be filled.

### Cracked Shells

1. *Avoid overbaking.* Once phenolic resins have reached their maximum strength additional baking reduces tensiles.

2. *Improve mixing practice.* Adequate mixing is essential to good shell strength.

3. *Check the sand additives (solid or moisture).* For any resin content, additives of small particle size result in a reduction of shell strength since the surface area of particles to be bonded is increased. In some shops, the intentional addition of fines to the mix, with the necessary increase in resin content, has proved to be beneficial. A good grain distribution of 4-6 screens is preferred to a one or two screen sand.

4. *Bed horizontal shells.* Shells positioned horizontally are easily imbedded in sand for pouring. Poorly bedded shells result in stress concentrations.

5. *Increase shell thickness or resin content.* A stronger shell by virtue of either thickness or resin content will better resist cracking or metal break-through.

6. *Use a slower curing resin.* Practice indicates that slower curing resins (lower hexa content) when sufficiently cured produce a less brittle bond than rapid cure resins.

7. *Check warped shells.* Shells which are warped at the time of ejection must undergo deflection to be bonded properly. Such deflection can result in the storing up of residual stresses in the bonded shell.

8. *Keep mold cavity away from shell edge.*

9. *Check for stress concentrations.* Any sharp corners, points, vents, or scratches are likely areas of high stress concentration, causing shells to crack when poured. Minor pattern modification may be necessary. This principle may be used beneficially in the elimination of hot tears on cylindrical castings.[2]

10. *Equalize pressure on bonding machine springs.* Uneven pressures can result in the bonding of shell halves with locked-in internal stresses or in a curved bonded shell. Pins of adjustable length are beneficial.

11. *Use maximum feasible pattern temperature and slightly undercure shell.* Under certain conditions, this practice has worked. The idea here is that the shell strength will increase momentarily after the metal is poured because of the undercured shell baking, whereas the high pattern temperature contributed to a skin of cured mix next to the pattern.

### Casting Fins

1. *Improve bonding or back-up practice.* In bonding, various glues and both liquid and dry phenolic resins are used. Sufficient time must be available to allow positioning of the second mold half before the adhesive begins to cure. Special bonding resins are preferable to shell resins since they remain plastic for a longer time at any specified temperature. The effect of temperature on the curing time of a dry phenolic bonding resin may be seen in the table.[3]

**HOLDING TIME FOR SHELL ASSEMBLY**

| Shell Temperature | Holding Time, Max. |
|---|---|
| 400F | 20 sec |
| 350F | 40 sec |
| 300F | 75 sec |
| 275F | 150 sec |

**Maximum holding time after dry phenolic bonding resin application before positioning second shell half. Delay in positioning second shell half longer than these times can result in a build up of cured resin between halves. Below 275F there is insufficient residual heat in shells to cure resin.**

2. *Clean mold surfaces before assembly.* Loose grains of sand or foreign materials will not allow shell halves to press firmly together.

3. *Clean pattern—avoid lubricant build up.* Additions or build-up on the pattern constitute a cavity with respect to the shell mold. Lubricant build-up, especially adjoining the casting pattern, will result in casting fins. Likewise, pattern depressions will result in high spots on the shells thus preventing flat mating of the halves.

4. *Check warped shells.* Warped shells seldom fit perfectly together

even when bonded, and will result in casting fins and other defects.

5. *Use resin with fast cure properties.* For a given operating cycle, casting fins may be reduced by using a faster curing resin. Shells should be fully cured when ejected from the pattern. Complete cure may also be accomplished at the expense of a longer curing time when using slower curing resins.

### Casting Surface Imperfections

1. *Correct pouring temperature.* In most alloys, the lowest permissible pouring temperature results in the smoothest casting surface. A few exceptions exist, such as some alloy steels, whereby smoothest finishes are obtained at temperatures somewhat above the minimum required to avoid misruns. Before beginning production runs it is always good practice to pour shells over a range of temperature to determine the optimum.

2. *Check poorly filled or imperfect shells.* A shell of low density will result in a rough casting surface (Fig. 5).

3. *Avoid nozzle ingates.* Consistent with good green sand practice, nozzle ingates are harmful and may be eliminated by either increasing ingate areas or choking the runner system.

4. *Avoid metal inclusions.* It is good practice to keep the downsprue full while pouring and to eliminate turbulence within the gating system. Downsprues of at least 1½ inches diameter are suggested to facilitate pouring. It is desirable to keep runners full at all times, particularly with drossing and high temperature alloys. While shell molds give metal greater apparent fluidity than green sand, their smoothness also facilitates the carrying along of inclusions.

5. *Position horizontally.* Shells positioned horizontally, compared with vertically, result in less metallostatic head and consequently have less tendency toward metal penetration.

6. *Check sintering point and grain size distribution of sand.*

### Casting Shrinks

1. *Use sufficient risers; position risers correctly.* While this is fundamental, it is sometimes overlooked in shell molding work. The nature of the molding material has been changed but not the nature of metal solidification. Shell molded castings must be fed. Shrinkage is usually concentrated into localized areas whereas dispersed porosity is not as likely in shell molded as in green sand castings. The feeding range of shell castings is approximately the same as in green sand castings.[4]

2. *Use larger, shorter ingates between riser and casting.* With the tendency to obtain greater yields, gating economy has sometimes resulted in ingates being too small. While it is true by the nature of shell molding materials that risers are molten a relatively long period of time, it must also be remembered that the casting is likewise solidifying at a commensurate rate and in the same material. Consequently, the ingate from riser to casting must be kept open the same as in green sand practice to effect adequate feeding.

3. *Gate through risers where feasible.* Shell molding does not vary in this respect from green sand practice.

4. *Avoid excessive pouring temperatures.* This is particularly true for castings without risers.

5. *Reposition or regate casting.*

6. *Avoid the casting feeding the runner.* To prevent this it is often desirable to use either a small or long ingate to expedite a freeze-off between the runner and casting. This is particularly desirable when the riser must be attached to the side of the casting and is not located between the runner and the casting.

Jack E. Bolt/*Tech. Svc. Engr.*
Chemical & Metallurgical Div.
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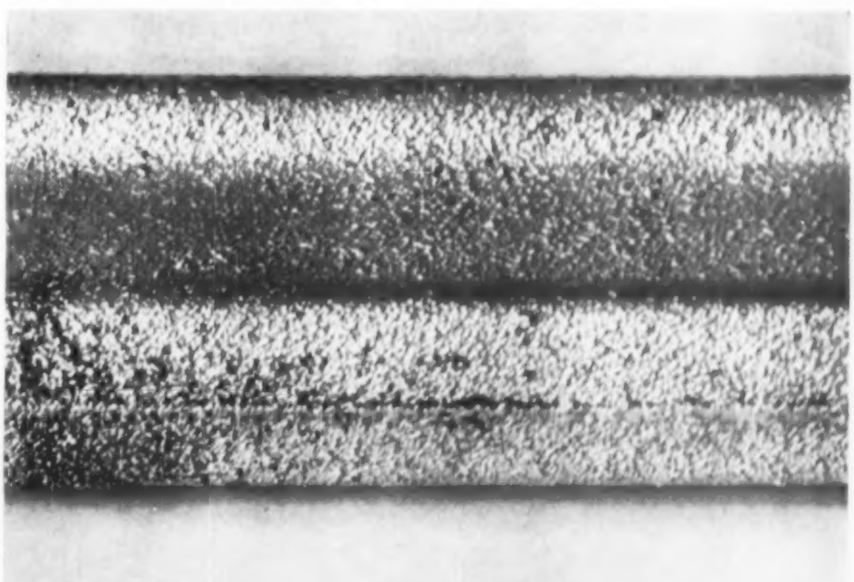
The author wishes to acknowledge and thank the many cooperative foundrymen in whose shops he has worked on shell molding problems, and specifically H. A. Taylor and A. J. Bzdula, of General Electric Company, Chemical & Metallurgical Division, who cooperated in the initial development of the experimental shell molding foundry laboratory at Pittsfield, Mass.

#### References

1. A detailed procedure for pattern conditioning may be found on Page 10 of G. E. Shell Molding Manual.
2. G. E. Foundry Facts #10, issued by Chemical & Metallurgical Division of General Electric Company, Pittsfield, Mass.
3. From G. E. Foundry Facts #8.
4. See next paper in this Bonus Section on shell molding.

**Fig. 5 . . Rough casting surface caused by low density shell mold wall.**



# What's the FEEDING RANGE in Shell Molds?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## Whether they're cast in shell or green sand castings need to be risered properly

■ It has been demonstrated[1,2] that the feeding characteristics of risers are related to the nature of wall growth of the solidifying metal. When wall growth is such as to develop a wide band of intermixed liquid and solid, feeding is difficult due to the obstructed paths for feed metal flow. Conversely, a narrow band of intermixed liquid and solid provides more open paths for feed metal flow thereby permitting greater feeding ranges. Thermal studies[3] have indicated that the wall growth mechanism of a solidifying alloy is related basically to the rate of heat transfer from the casting to the mold.

Iron chill molds for example are capable of removing heat from solidifying alloys at rates such that solidification, depending upon the type of alloy, occurs up to 20 times as fast as for sand molds, changing wall growth characteristics from a wide band to a narrow band type. Thermal studies also have shown[4] that shell molds backed with steel shot reduce the solidification times of several common foundry alloys by amounts up to 40 per cent of their solidification times in conventional sand molds. An example for the case of nodular iron is shown in Fig. 1.

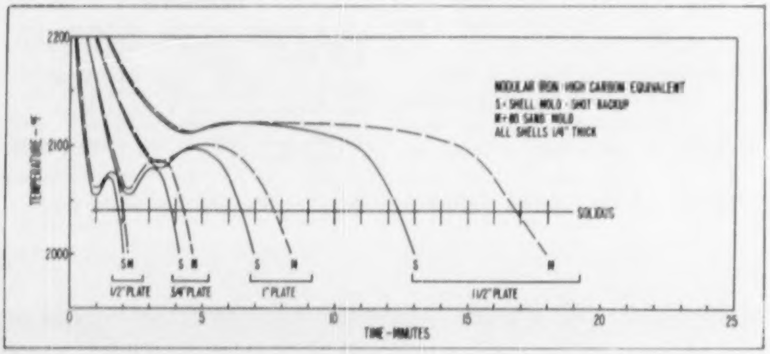
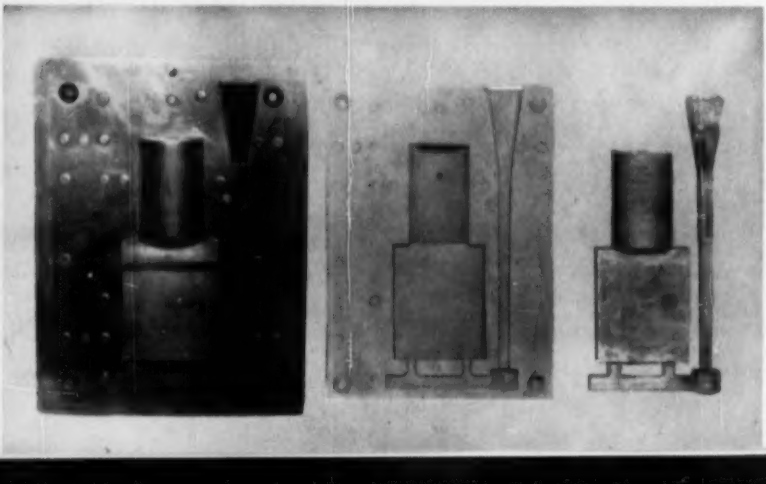



Fig. 1 . . Molten metal in steel shot backed shells solidifies faster.

Fig. 2 . . Pattern, shell, and test casting used in feeding study.



### Feeding Ranges Could Differ

While the change in heat transfer rates in shell-shot mold systems is relatively small compared to the change obtained by the use of chill molds, the possibility existed that this difference may be of sufficient magnitude to result in feeding characteristics different from those in sand molds. Since much research has been conducted on the feeding range of risers for steel castings in sand molds, it was considered of interest to determine whether these data are also applicable to steel castings made in shell molds backed with steel shot. Accordingly, the feeding range of risers on steel plates cast in shell molds was determined in order to establish this correlation.

Since there are very little data available relative to the distance which risers can feed castings other than steel, either for the case of

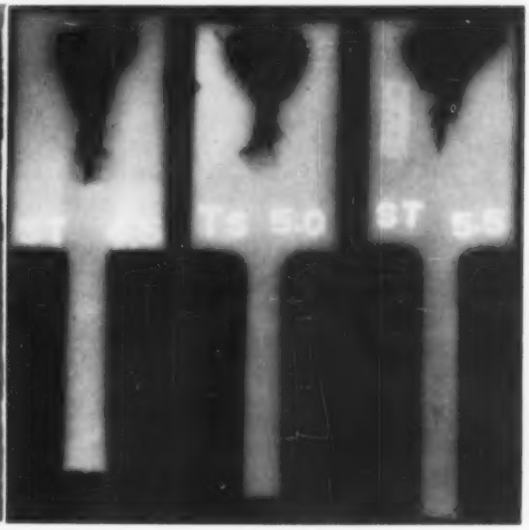



**Fig. 3** . . Typical centerline shrinkage at left. **Fig. 4** . . At right shrinkage begins to develop as critical feeding length is exceeded.

sand or shell molds, the work was extended in an attempt to determine these data for plate castings of other metals. These studies included G bronze, gray iron, nodular iron with high and low carbon equivalents 4½% copper-aluminum, 7% silicon-aluminum and manganese bronze.

### Experimental Procedure

The shells for the test castings were made with a washed and graded silica sand, AFS No. 150, mixed with 7 per cent of a shell molding resin. Figure 2 illustrates a pattern plate, a shell and one of the test castings. The shells were approximately ¼ in. in thickness and were cured at 450 F for 30 to 45 seconds.

Sixty-four different pattern assemblies were required to produce the necessary variations in plate thickness and corresponding feeding range. This was done on two pattern plates by attaching and removing the pattern parts as necessary. The shell molds were placed in steel boxes which were then filled with steel shot and compacted by vibration.

Shells were made for plate castings having thicknesses of ½, ¾, 1 and 1½ in. Each plate had a width of five times its thickness and was fed with a riser having a diameter equal to three times the plate thickness. The length of the plate was varied from three to eight times the casting thickness, and the maximum length which could be made sound was considered to be the feeding range of the riser. To determine the condition of soundness, two parallel saw cuts were made through the riser and casting to remove a slice approximately ½ in. thick and a transverse radiograph was made of this section.

The nominal compositions of the various alloys and the pouring temperatures employed are shown in Table 1.

### Feeding of Alloys Exhibiting Centerline Shrinkage

Of the alloys listed in Table 1, only steel, manganese bronze, and the two nodular irons exhibited the true centerline type of shrinkage (Fig. 3). Figure 4 shows typical conditions of soundness of alloys of this type when casting lengths are in the vicinity of the critical lengths. It can be noted that as the critical length is exceeded shrinkage develops and becomes more clearly defined with a further increase in length. Several plates having lengths near the critical were cast. While there was some variation in the maximum plate length which could be made sound, it did not exceed ±½T.

The presence or absence of centerline shrinkage in the plates made with various combinations of length and thickness and cast with alloys exhibiting centerline shrinkage are indicated on the graphs of Fig. 5 to 8 inclusive. It can be noted that the results obtained for steel plates (Fig. 5) are in close agreement with the data obtained for similar plates cast in sand molds[3]. For thicknesses of 1 in. and greater the feeding distance is 4½ times the plate thickness (4½T) and 5½ to 6T for the ¾ and ½-in. thick plates. However, the deviation from the 4½T rule does not exceed 1 in. even for the case of the thinnest plate.

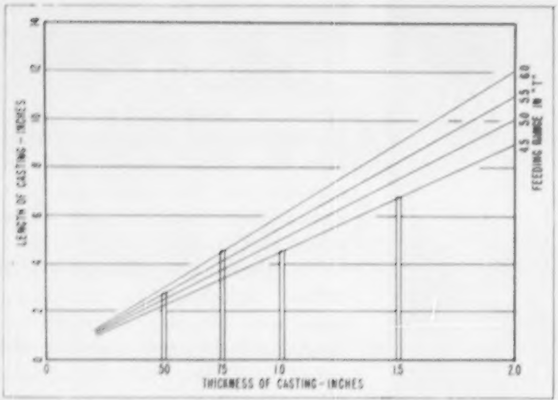
### Thin Plates Above Average

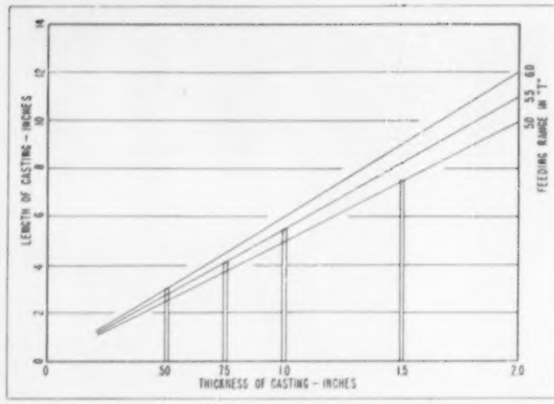
The average feeding distances in plate castings made of manganese bronze, high carbon equivalent and low carbon equivalent nodular irons (Fig. 5, 7 and 8) are 5½T, 6½T and 6T respectively. It should be noted that the feeding ranges in the thinner plates in all cases tend to exceed the average by about ½T while the 1½-in. thick plates are ½T below the average distance. Figure 9 illustrates the slight amount of shrinkage observed in a 1-in. thick nodular iron plate having a length ½T above the maximum feeding range.

The data for nodular irons differ from similar feeding range data obtained by Shnay and Gertsman[5]

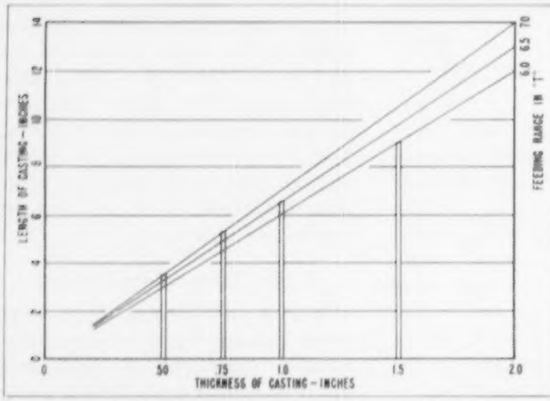
**TABLE 1 . . CHEMICAL ANALYSES AND POURING TEMPERATURES**

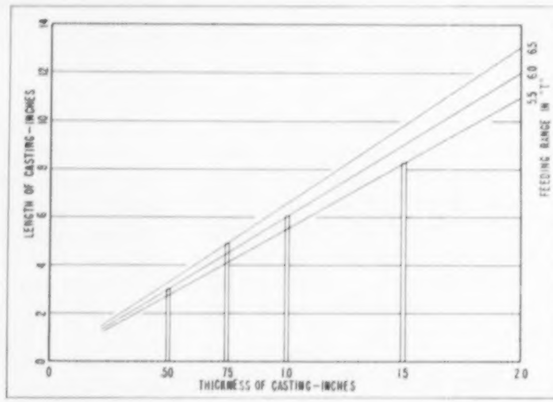
| | Composition, % | | | | | | | | Pouring Temp., |
|---|---|---|---|---|---|---|---|---|---|
| | Al | C | Cu | Fe | Mn | Si | Sn | Zn | F |
| Steel | | 0.25 | | Balance | 0.80 | 0.60 | | | 2900 |
| Gray Cast Iron | | 3.70 | | Balance | 0.30 | 2.35 | | | 2400 |
| Nodular Iron, High CE | | 3.35 | | Balance | 0.40 | 2.55 | | | 2500 |
| Nodular Iron, Low CE | | 2.90 | | Balance | 0.35 | 2.10 | | | 2500 |
| G Bronze | | | 89.1 | | | | 8.2 | 2.7 | 2000 |
| Manganese Bronze | 0.7 | | 57.3 | 0.8 | 0.4 | | 0.2 | 40.6 | 1800 |
| Aluminum (Cu) | 95.5 | | 4.5 | | | | | | 1300 |
| Aluminum (Si) | 93.0 | | | | | 7.0 | | | 1300 |




**Feeding range** in castings poured in shell molds. **Fig. 5 (upper left)** . . Steel. **Fig. 6 (upper right)** . . Manganese bronze. **Fig. 7 (lower left)** . . Nodular iron (CE 4.20). **Fig. 8 (lower right)** . . Nodular iron (CE 3.60).




for horizontal plate castings made in sand molds. These investigators found that the maximum feeding range was essentially independent of casting thickness, being 4½ to 5½ in. for plates ½ to 1½ in. thick; in terms of T the feeding ranges reported by Shnay and Gertsman for ½, 1 and 1½-in. plates would be 10T, 5½T and 3T respectively.

### Feeding of Gray Iron Compared to Nodular Iron

Despite the fact that gray iron has essentially the same analysis as nodular iron, gray iron plates were found to be sound in lengths up to 8T (the maximum lengths tested). From theoretical considerations it is believed that the feeding ranges in uniform sections made of gray iron are very great, if not infinite. The reason for the differences in feeding characteristics of gray and nodular irons is due to the differences in the mode of formation of flake and nodular graphite.[7, 8]

Flake graphite forms directly from the eutectic liquid and the resultant increase in volume can force the movement of interdendritic liquid to either fill or prevent the development of shrinkage cavities. Graphite nodules, however, while "born" in liquid undergo the major portion of their growth cycle by malleabilization of the carbide eutectic phase.

Since the nodules are not in contact with liquid during this period it is not possible to readily force the movement of liquid into shrinkage voids. The result of these different solidification modes is that a gray iron casting can be considered essentially "self feeding" after the eutectic reaction temperature is reached while nodular iron castings behave in this fashion only to a limited extent. Obviously, a volumetric expansion must accompany the formation of the low density graphite nodules even though they grow from solid metal and it has been shown[7] that a volume expansion of the casting does accompany nodule formation.

### Gray Iron Self Feeding

Since the nodules grow in size near the surface of the casting at a time when the casting center is partially molten, an inward expansion as well as an outward movement of the solid wall must occur at this time to force some reaction upon the remaining liquid. Apparently there is a sufficient amount of nodule growth and inward expansion occurring within the casting before the end of its solidification to result in a limited amount of "self feeding".

The extent of such feeding is reflected in the increased feeding range of nodular irons as compared to steel. This behavior is logically

**Fig. 9 . . Centerline shrinkage at 6½T, nodular iron.**

**Fig. 10 . . Radiographs of ¼-in. pressure test specimens from 6T plates (l. to r.) 3/4, 1, 1½ in. thick, cast in sand (upper), shell-shot (lower).**

accentuated with a closer approach to eutectic composition which would account for the fact that the high carbon equivalent iron has a slightly longer feeding range than the low carbon iron.

### Feeding of Non-Ferrous Alloys

X-ray examination of castings made of the two aluminum alloys and gun metal bronze showed broadly distributed interdendritic porosity in all castings, regardless of their length and thickness. Such porosity is inherent to the subject alloys and originates both from gas precipitation and interdendritic shrinkage. These alloys in the molten state readily dissolve large amounts of gases, while upon solidification the amount of gas which can be retained in solution is very small; hence the excess gas is rejected to form porosity voids. In addition the thermal properties of these alloys, i.e., high conductivity and/or long solidification range, results in an extremely mushy type of wall growth which makes feeding to complete soundness very difficult in molds having low thermal diffusivity.

On the basis of the transverse radiographic tests the feeding range of aluminum and bronze alloys is effectively nil. Admittedly this test is very sensitive since it can detect porosity which is not visible on radiographs taken in the normal manner. Moreover it should be recognized that x-ray evidence of dispersed porosity in non-ferrous castings does not necessarily imply that leakage is a certainty. In fact such x-ray evidence is oftern misleading, an observation which led the authors to conclude that there is no substitute for actual pressure tightness tests for evaluating leakage characteristics of non-ferrous alloys.[2,9] Accordingly, feeding range studies of non-ferrous castings prone to leakage have been conducted by pressure tests.

In order to determine the pressure tightness range for bar castings in previous studies, ¼-in. thick cross-sectional slices were removed from the bars at 3-in. intervals along their lengths and if all such slices from a given bar could withstand 400 psi hydraulic pressures the bar was considered sound. Plate-like castings having a thickness of 1 in. were examined by reducing their thickness to ¼ in. by removing equal amounts of metal from each surface and subjecting them to a hydraulic pressure of 400 psi. Absence of leakage indicated soundness.

Such criteria for soundness are extremely severe since they expose to hydraulic pressures the centerline portions of the castings which are the locations of most difficult feeding. Thus it can be assured that castings passing these tests are of the highest practical degree of soundness.

In the present study 4 x 4¼-in. specimens were removed from the centerline region of ¾-, 1- and 1½-in. thick plates, 6T in length, which had been cast from the same heat into both sand and shell molds. All of the specimens were able to withstand 400 psi hydraulic pressures despite the presence of porosity (Fig. 10). On the basis of this evaluation it would be concluded that the feeding range in G bronze plates in terms of pressure tightness is a least 6T for the case of ¾- to 1½-in. thicknesses.

The feeding range in non-ferrous alloys was not explored further since pressure tightness in these alloys is influenced to a great extent by gas content of the melt which has not been subject to exact control by practical foundry methods. This subject is discussed in companion papers[9,10] which describe a new procedure for obtaining low gas contents in the melt and also the improvements in the soundness and pressure tightness obtained in castings poured with such melts.

### Sand and Shell Mold Castings

The difference in heat transfer characteristics of conventional sand molds and shell molds apparently is not sufficiently great to affect feeding ranges. This is evidenced by the fact that the feeding range

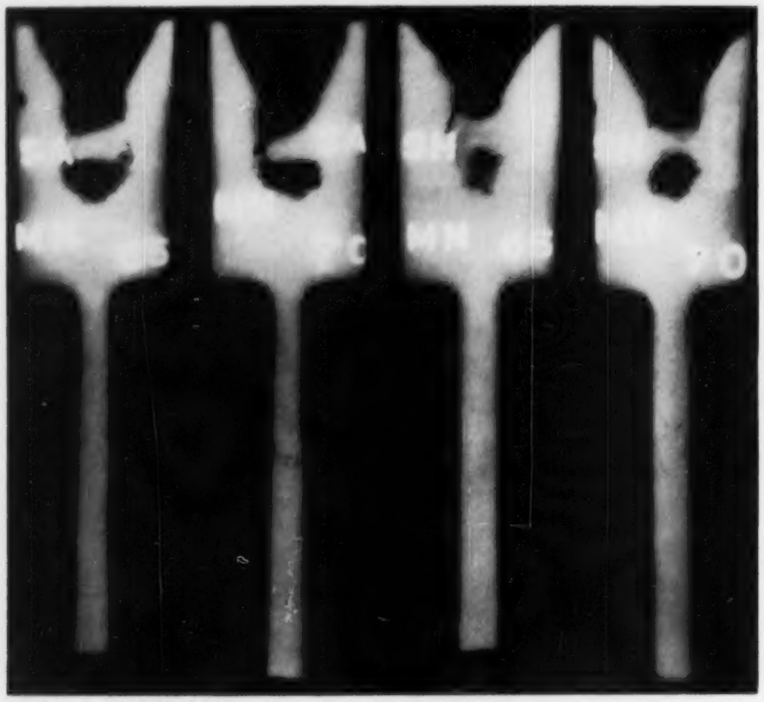


**Fig. 11 . . Radiographs show shrink similarity in manganese bronze cast in regular sand (two at left) and in shell mold with shot back-up.**

of steel plates is 4½T in both cases. It may be assumed that the formulas developed for feeding ranges in sand cast steel bars,[11] joined sections,[12] padded sections[13] and shell castings without modification.

Spot checks on other alloys have indicated no significant differences in feeding characteristics resulting from the two mold media. Figure 11 for example shows x-rays of strips removed from identical manganese bronze plate castings made in both sand and shell molds. It may be observed that not only is the severity of the shrinkage within the casting alike (casting lengths were in excess of the feeding range) but the appearance of the shrinkage in the risers is also the same.

### Summary

▪ 1. The feeding ranges in ½- to 1½-in. thick shell molded plates cast of alloys which exhibit centerline shrinkage are as follows:

| | |
|---|---|
| Steel .................... | 4½T |
| Manganese Bronze ........ | 5½T |
| Nodular Iron (CE = 4.2) .. | 6½T |
| Nodular Iron (CE = 3.6) .. | 6T |

where T = plate thickness

▪ 2. Gray iron can be fed for essentially semi-infinite distances due to the fact that graphite precipitation results in "self feeding".

▪ 3. Aluminum-7% silicon, aluminum-4% copper and G bronze develop uniformly distributed porosity irrespective of casting length. Feeding distance based upon transverse radiography examinations are essentially of nil value. Pressure tightness tests indicate feeding distances on the order of 6T or greater; however, gas content is known to be an important variable here.

▪ 4. Feeding range data obtained for conventional sand molds are applicable to shell molds.

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## Committee to Study Shell Tensile Test

Shell molding will have a control tensile test when the Shell Molding Materials Testing Committee of the American Foundrymen's Society completes its current project. The specimen will be a ¼-in. thick standard tensile briquet with tolerance of + 0.010-in. (no minus tolerance) on 0.250-in.

Because the test is for control purposes, production sand mixes will be used in its development. The tube method of investing is to be used; the pattern will have a hot bottom and side plate—heated to 450 F and allowed to cool to 400 F. Release agent, if any, will be that used in production and cure time will be four minutes.

Time between investment and placing in oven should be as short as possible and uniform from test to test. Results will be the average of tests on six specimens cooled to room temperature prior to testing.

Future committee work may include transverse testing, sand density and flowability characteristics, hot permeability, flexural, and deflection testing. Cold permeability test and shrink rule for patterns are other possibilities.

A test casting is being designed for evaluation of proposed tests.

## pouring off the heat

*continued from page 16*

*est that so many people have shown. Maybe more advance warning would have eased the apparent shock.*

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**Manganese steel flat-link chain for dragline buckets is cast interlocked.**

# Chain Casting Secrets

**How did you think those links got joined together, anyway?**

Bill Walkins / *Editor, The ESCO Ladle*
*Electric Steel Foundry Co., Portland, Ore.*

■ Chain casting at Electric Steel Casting Co. is actually casting assembly of precast links. Every other link, which is cast in green sand, is integrated into a chain by casting connecting links in a core mold-link assemblage.

Precast links with risers removed are placed horizontally on drag sections of connecting link cores then covered with cope sections. This completely "coring around" of the precast link forms the mold for the vertically cast connecting link. The chain casting set-up is conveniently wedged in the trough of an I-beam.

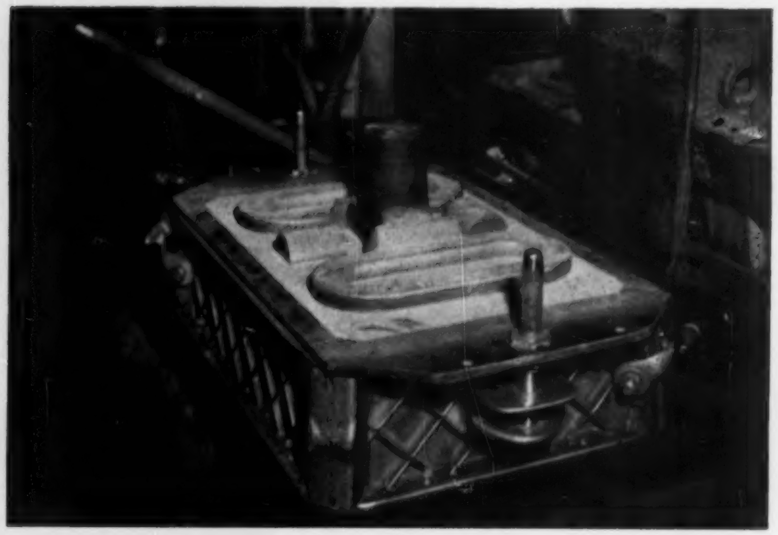
Cores for the connecting link assemblage are made from all banding sand bonded with 2 per cent fire clay, 1 per cent corn flour, 1½ pints of linseed oil to 100 lb sand, a trace of western bentonite, and from 2.4 to 2.6 per cent water. Moisture is critical and thorough baking is necessary.

Steel is transferred to shank ladles at the pouring station and allowed to cool to a critical temperature zone of approximately 2680 F. From this temperature the manganese steel alloy solidifies into a casting of ideal grain size. Of course, constant checking of metal temperature during pouring is required.

Cleaning and finishing consists of removing risers on the connecting links, grinding the riser stubs on all links, and sand blasting.

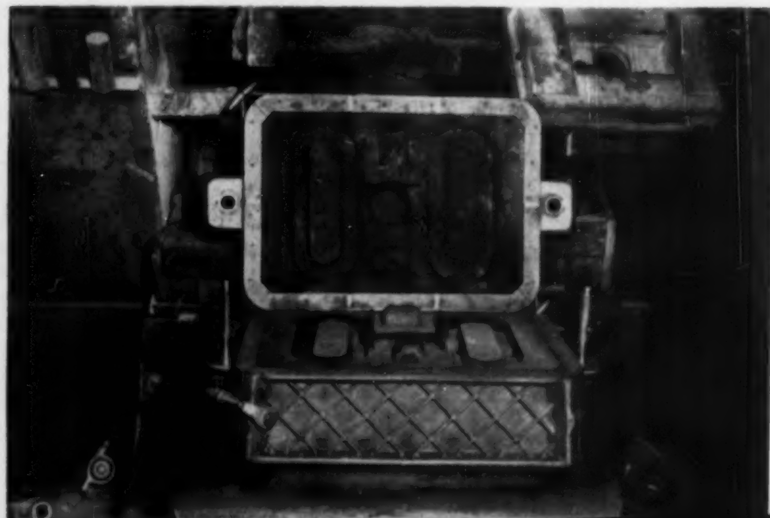
To improve wear and shock resistant properties of the already durable manganese steel, the chain is subjected to a special heat treatment. For instance, a chain of 2½-in. links is heated to 1550 F and held there for one hour, then stepped up to 1900 F for another three hours, then on up to 1950 F for 30 min before quenching immediately in water.

Advantages of casting chain are that there is no limit to chain material or design. In this case, the material is a special manganese alloy steel whose durable properties are further improved by heat treatment. The casting process allows chain to be designed for a maximum of link-to-link bearing surface. Flat link design provides the chain with a cross section that averages 19 per cent greater than a round link chain of similar dimensions.



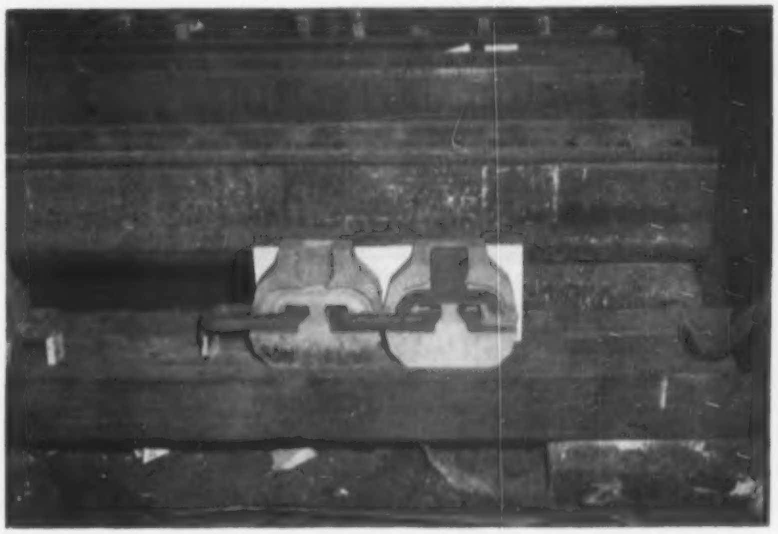
**1** **Every other link of cast chain is cast in green sand molds, jolt-squeezed with matchplate pattern and pop-off flasks in mechanized foundry.**

**2** **With pattern drawn, cope and drag show the placement of break-off cores and cylindrical guides which prevent cope shifting on the drag.**



**3** Cores for the connecting links are produced on a core blower from all new banding sand bonded with fire clay, corn flour, and linseed oil.

**4** Preparation for casting connecting links consists of placing half-cores in I-beam trough, then setting precast links horizontally in place.

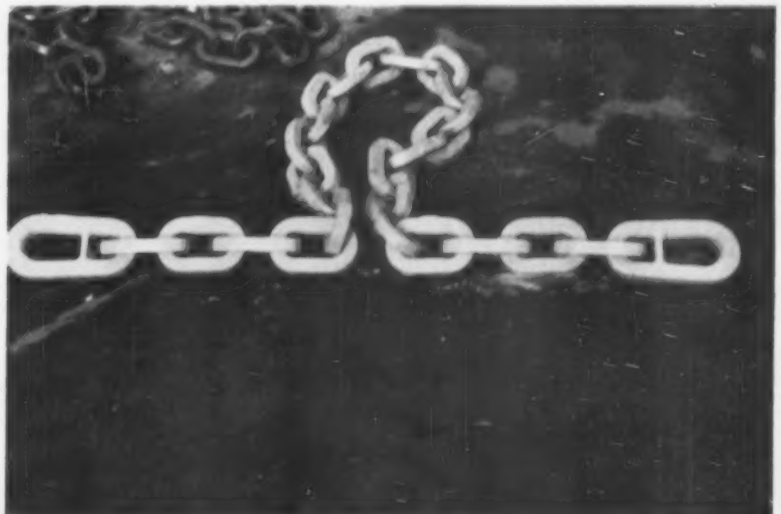


**5** Then the top half of the vertical connecting link core assemblage is set in place, completely "coring around" the horizontal precast link.

**6** Cutaway section of core assemblage with inserted section of wooden dummy link shows how vertically cast link connects horizontal link.

**7** Three-link set-up is held in place with wooden wedges and hand poured with manganese steel allowed to cool to proper temperature.

**8** Finishing the completed cast chain consists only of removing risers from the connecting links, grinding riser stubs, and sand blasting.



# One Iron in the Cupola— Many in the Ladle

**Grant E. Spangler**
*Air Reduction Research Lab*
*Murray Hill, N. J.*

R. Schneidewind / *Professor*
*Chemical & Metallurgical Engineering*
*University of Michigan, Ann Arbor*

**Ladle injection can give controlled increases of up to 1% carbon in 3 minutes or less**

■ Carbon content of acid cupola irons is controlled by the nature of the metallic charge, the coke ratio, the quality of the coke used, the amount of blast, and by variations in cupola operation, such as changing the height of the coke bed or by the use of a hot blast. The amount of carbon absorbed by the iron during its passage through the cupola can be approximated by the well-known Levi[1] formula which reads:

$$\%C \text{ at the spout} = 2.4 + \left(\frac{\%C}{2}\right) \text{in the charge} - \left(\frac{\%Si + \%P}{4}\right) \text{at the spout}$$

Although this expression is reasonably accurate over a wide range of conditions, it must be pointed out that the arbitrary constant 2.4 will vary with temperature, reactivity of the coke, and many other factors.

In the average foundry where cupola operations have been standardized, the control of carbon content is generally secured by the proportion of pig iron charged. During the war and in the post-war period coke of good quality was not always obtainable and foundrymen found it difficult to procure adequate quantities of pig iron. Many schemes were used in an attempt to maintain uniform spout compositions. Silicon carbide or calcium carbide in lump form were placed in the coke bed. Graphite electrodes or carbon blocks were similarly used. Despite these methods, many foundrymen experienced trouble in securing uniformly desirable results day by day.

Ladle treatments with granular graphite usually result in negligible pick-up. This problem has adequately been discussed by Pearce[2] and by Angus.[3] The latter states, "Carbon in the form of graphite is quite frequently used as a mild inoculant for the control of chill, but it is very difficult to obtain a pick-up in the ladle of greater than about 0.1 to 0.15 per cent. Additions of fine graphite to the ladle are likely to produce a considerable amount of dirt, both in the foundry itself by air flotation and also in the ladle as scum."

It will be shown in this paper that carbon can be introduced in molten cast irons in a ladle or a forehearth by the injection process. Increases of up to 1.0 per cent carbon have been made consistently in three minutes or less. Efficiencies of recovery have ranged from 50 to 100 per cent, depending upon the size of the carbon particles used, the purity and physical nature of the carbon, and the temperature at which injection is carried out.

**Table 1 — Cast Irons Injected with Carbon in a Basic-Lined Induction Furnace**

| Heat No. | % C Added | Type Carbon | Temp., F | %Si | % C Before | C.E. Before | % C After | C.E. After | Efficiency % | Chill Depth, 1/32 in. Before | Chill Depth, 1/32 in. After | U.T.S., psi Before | U.T.S., psi After | BHN Before | BHN After |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.55 | Graphite | 2800 | 1.88 | 3.11 | 3.77 | 3.60 | 4.26 | 89 | 24 | 4 | 31,400 | 22,200 | 201 | 152 |
| 2 | 0.55 | Graphite | 2770 | 1.85 | 3.16 | 3.81 | 3.69 | 4.34 | 96 | 24 | 2 | 31,700 | 21,800 | 197 | 143 |
| 3 | 0.488 | Graphite | 2600 | 2.07 | 2.69 | 3.42 | 3.14 | 3.87 | 92 | 4 | 2 | — | 37,650 | — | 192 |
| 4 | 1.00 | Graphite | 2800 | 1.36 | 2.98 | 3.48 | 4.05 | 4.53 | 100 | 42 | 8 | — | 25,200 | — | 161 |
| 5 | 0.76 | Graphite | 2750 | 1.39 | 2.79 | 3.29 | 3.48 | 3.97 | 91 | 50 | 6 | — | 32,500 | — | 174 |
| 6 | 0.562 | Gas Coke | 2800 | 1.95 | 2.94 | 3.64 | 3.25 | 3.94 | 60 | 16 | 4 | — | 41,700 | — | 207 |
| 7 | 1.05 | Baked Pet. Coke | 2800 | 2.14 | 2.84 | 3.59 | 3.51 | 4.28 | 64 | 16 | 4 | 36,600 | 28,400 | 217 | 174 |
| 8 | 0.50 | Baked Pet. Coke | 2700 | 1.89 | 3.15 | 3.78 | 3.36 | 4.00 | 44 | 38 | 8 | 33,900 | 32,250 | 187 | 170 |
| 9 | 0.55 | Calcined Anthracite | 2610 | 1.96 | 2.93 | 3.62 | 3.03 | 3.72 | 31 | 28 | 3 | 40,000 | 38,600 | 193 | 205 |
| 10 | 0.55 | Calcined Anthracite | 2600 | 1.98 | 3.03 | 3.72 | 3.31 | 4.00 | 57 | 26 | 1 | 34,650 | 31,900 | 197 | 174 |
| 11 | 0.50 | Wood Charcoal | 2800 | 2.20 | 2.88 | 3.64 | 3.15 | 3.93 | 72 | 12 | 4 | — | 44,200 | — | 201 |

500-lb heats, induction furnace
Feed Rate—4 lb. carbon/minute
Mesh Size—20 x 100
Efficiencies based upon fixed carbon

**Table 2 — Cast Irons Melted in a Basic-Lined Induction and Injected with Carbon in an Acid-Lined Ladle**

| Test No. | % C Added | Type Carbon | Temp., °F | % S | % C Before | C.E. Before | % C After | C.E. After | Efficiency, % | Chill Depth 1/32 in. Before | Chill Depth 1/32 in. After |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.50 | Graphite | 2690 | 2.15 | 3.36 | 4.11 | 3.72 | 4.47 | 72 | 10 | 1 |
| 2 | 0.50 | Graphite | 2550 | 1.77 | 3.50 | 4.17 | 3.76 | 4.37 | 52 | 8 | 2 |
| 3 | 0.30 | Graphite | 2680 | 2.35 | 3.44 | 4.27 | 3.65 | 4.48 | 70 | 9 | 2 |
| 4 | 0.50 | Baked Coal* | 2660 | 2.09 | 2.94 | 3.68 | 3.33 | 4.06 | 84 | 19 | 0 |
| 5 | 0.50 | Baked Coal* | 2730 | 2.09 | 2.96 | 3.69 | 3.23 | 3.96 | 56 | 19 | 5 |
| 6 | 0.50 | Graphite | 2740 | 2.11 | 2.89 | 3.63 | 3.28 | 4.01 | 78 | 16 | 4 |
| 7 | 0.50 | Graphite | 2680 | 1.97 | 2.87 | 3.56 | 3.36 | 4.05 | 98 | 27 | 1 |
| 8 | 0.50 | Graphite | 2660 | 1.96 | 2.87 | 3.56 | 3.29 | 3.98 | 83 | 29 | 2 |

500-lb heats, induction furnace
Feed Rate — 4 lb of carbon per minute
Mesh Size — 20 x 100
Ladle — 500 lb, lined with 80% $Al_2O_3$ — 20% $SiO_2$

*Baked coal was processed by heating it to 1200°F for four hours for the purpose of driving off most of the volatile matter.

### Procedure of Injection

Batches of carbon in the form of electric-furnace graphite, coke, anthracite coal, petroleum coke, and other varieties were prepared in the size range of minus 20 plus 100 mesh. Chemical analyses were made to determine the ash content, the proportion of volatile material, and

the amount of fixed carbon.

The various types of carbon were injected either alone or as mixtures with calcium carbide into molten irons held in a 500-lb high-frequency induction furnace. The injection rate was 4 lb of carbon per minute; nitrogen gas was used as a carrier and was supplied at 1.25 cu ft per min (75 cu ft per hr).

When injection was completed, samples were poured for determining chill and composition, and 1-in. keel blocks were poured for mechanical properties and microstructure.

### Recovery of Carbon After Furnace Injection

Table 1 shows the compositions of a typical group of irons prior to and after injection. The quantity and type of carbon used is given. All the carbon in each case was introduced in from 30 sec to less than 3 min.

The results indicate that highest recoveries were obtained with electric-furnace graphite. Even when based upon fixed carbon only, the other forms of carbon exhibited lower recovery values as the amount of ash and volatile material increased. Some materials containing significant proportions of volatile matter appear to be unsuitable commercially because of the violence of reaction when injected.

The efficiency of carbon injection could be approximated visually by observing the amount of unreacted carbon floating to the surface of the melt during injection. When electric-furnace graphite was injected, faint patches of a solid carbon film were sometimes visible at the edge of the vessel. These disappeared in a few seconds, presumably by going into solution. Some of the less efficiently absorbable forms of carbon showed much larger quantities of unreacted material floating to the surface.

Three of the factors contributing to a high rate of carbon absorption by the injection process may be suggested as follows:

- The carbon is introduced below the surface of the liquid iron where there is a minimum chance for contact with acid slags, which tend to wet carbon and to form a film over it.
- The carbon particles are injected into the melt with good mixing.
- The relatively small size of particles offers a large surface area to the iron. The size range used in this work and in the foundries where the process has been tested is minus 20 mesh. If it is assumed that the average particle is spherical and is of 50-mesh size (diameter = 0.0117 in.), 1 lb of graphite will have a surface area of greater than 5,680 sq in.

### Recovery of Carbon After Ladle Injection

The injections just described were made at 2800 F in an induction furnace where a condition of stirring exists. It was felt desirable to conduct carbon injections in a ladle to simulate plant conditions more closely. The melts were superheated to 2800 F and transferred to a ladle where carbon was injected at temperatures between 2650 and 2700 F.

Table 2 presents the results of representative heats injected with carbon in the ladle. The efficiency of carbon recovery is somewhat lower under these ladle conditions, and the desirability of using a carbon

**Table 3 — Cast Irons Melted in an Acid Cupola and Injected with Carbon in Acid-Lined Ladles**

| No. | Wt. of Iron | % C* Added | Feed Rate | Graphite Mesh | % Si | % C Before | C.E. Before | % C After | C.E. After | Efficiency, % | Chill Depth 1/32 in. Before | Chill Depth 1/32 in. After | U.T.S., psi Before | U.T.S., psi After | BHN Before | BHN After |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 0.90 | 4.00 | 20 x 100 | 2.09 | 3.32 | 4.05 | 3.66 | 4.39 | 36 | 7 | 2 | 35,300 | 24,300 | 183 | 144 |
| 2 | 790 | 0.20 | 4.00 | 20 x 100 | 2.18 | 3.18 | 3.94 | 3.37 | 4.13 | 95 | 8 | 5 | 38,000 | 34,100 | 197 | 172 |
| 3 | 1725 | 1.04 | 5.35 | 20 x 100 | 2.22 | 3.37 | 4.14 | 3.80 | 4.57 | 41 | — | — | — | — | — | — |
| 4 | 1850 | 0.27 | 5.35 | 20 x 100 | 2.22 | 3.42 | 4.19 | 3.50 | 4.27 | 63 | — | — | — | — | — | — |
| 5 | 1280 | 0.39 | 4.00 | −40 | 2.30 | 3.41 | 4.21 | 3.57 | 4.37 | 41 | 4 | 2 | — | — | — | — |
| 6 | 1070 | 0.47 | 4.00 | −40 | 2.09 | 3.37 | 4.10 | 3.60 | 4.33 | 49 | 2 | 1 | — | — | — | — |
| 7 | 1160 | 0.43 | 4.00 | 35 x 40 | 2.30 | 3.28 | 4.08 | 3.59 | 4.39 | 72 | 4 | 2 | — | — | — | — |
| 8 | 1180 | 0.42 | 4.00 | 35 x 40 | 2.09 | 3.38 | 4.11 | 3.60 | 4.33 | 52 | 4 | 2 | — | — | — | — |
| 9 | 1420 | 0.35 | 3.25 | 20 x 100 | 2.17 | 3.41 | 4.17 | 3.62 | 4.38 | 60 | 6 | 2 | — | — | — | — |
| 10 | 1620 | 0.31 | 3.25 | 20 x 100 | 2.00 | 3.33 | 4.03 | 3.50 | 4.20 | 55 | 6 | 2 | — | — | — | — |
| 11 | 1890 | 0.21 | 4.00 | 20 x 100 | 2.00 | 3.16 | 3.86 | 3.28 | 3.98 | 57 | — | — | 42,400 | 35,600 | 197 | 187 |
| 12 | 1840 | 0.44 | 4.00 | 20 x 100 | 2.00 | 3.06 | 3.76 | 3.31 | 4.01 | 58 | — | — | 39,000 | 30,100 | 199 | 156 |
| 13 | 1590 | 0.15 | 4.00 | 20 x 100 | 2.18 | 3.20 | 3.96 | 3.32 | 4.08 | 80 | 9 | 6 | 42,300 | 39,300 | 207 | 197 |
| 14 | 1170 | 0.82 | 4.00 | 20 x 100 | 2.18 | 3.24 | 4.00 | 3.65 | 4.31 | 50 | 9 | 2 | 38,400 | 22,100 | 192 | 149 |

Silicon contents based upon control silicon analyses
Late FeSi added prior to injection in all cases
P — 0.10%  S — 0.08%  Mn — 0.70% Nominal Analyses
Acid Cupola, Balanced Blast
Injection Temperature 2600-2700 F
*All injected carbon used was electric furnace graphite

**Table 4 — Cast Irons Melted in Both Acid and Basic Cupolas and Injected with Carbon in Acid-Lined Ladles**

| No. | % Si | % C* Added | % C Before | C.E. Before | % C After | C.E. After | Efficiency, % | Chill Depth 1/32 in. Before | Chill Depth 1/32 in. After | Cupola |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.60 | 0.30 | 3.57 | 4.10 | 3.75 | 4.28 | 60 | 4 | 0 | Acid & Basic |
| 2 | 1.43 | 0.30 | 3.44 | 3.92 | 3.71 | 4.19 | 90 | 12 | 0 | Acid & Basic |
| 3 | 1.51 | 0.37 | 3.30 | 3.80 | 3.62 | 4.12 | 87 | 3 | 2 | Basic |
| 4 | 1.40 | 0.40 | 3.36 | 3.83 | 3.76 | 4.23 | 100 | 4 | 2 | Basic |
| 5 | 1.42 | 0.29 | 3.42 | 3.89 | 3.69 | 4.16 | 94 | 7 | 2 | Basic |
| 6 | 1.44 | 0.29 | 3.44 | 3.92 | 3.67 | 4.15 | 80 | 5 | 3 | Basic |
| 7 | 1.70 | 0.40 | 3.30 | 3.87 | 3.54 | 4.11 | 60 | 3 | 3 | Acid |
| 8 | 1.65 | 0.40 | 3.30 | 3.85 | 3.59 | 4.14 | 72 | 4 | 1 | Acid |
| 9 | 1.70 | 0.40 | 3.34 | 3.91 | 3.59 | 4.16 | 62 | 7 | 4 | Acid |

Ladle Weight — 3500 lb
Injection temperature 2650-2750 F
Graphite Mesh Size — 20 x 100
Feed Rate — 5.35 lb/min
Late FeSi added prior to injection in all cases
*All injected carbon used was electric furnace graphite

**Table 5 — Microstructures of Soft Gray Irons Made with Injected Carbon***

| Where Made | Late Silicon | %C | %Si | %Mn | %S | Tensile Strength psi | Brinell Hardness | Structure | Graphite Type & Size | % Pearlite | Chill in. | Bar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Laboratory | No | 3.69 | 1.73 | .63 | .006 | 21700 | 143 | Fig. 8a | A-4 | 100 | 1/16 | 1 in. keel |
| Laboratory | Yes | 3.75 | 1.98 | .63 | .005 | 18500 | 149 | Fig. 8b | A-5 | 100 | 1/16 | 1 in. keel |
| Foundry | Yes | 3.66 | 2.09 | .70 | .08 | 21300 | 144 | Fig. 8c | A | 98 | | B |
| Foundry | Yes | 3.65 | 2.18 | .70 | .08 | 22100 | 149 | Fig. 8d | A | 98 | | B |

*All injected carbon used was electric furnace graphite

such as electric furnace graphite, which has a rapid rate of solution, is emphasized.

### Effect of Foundry Conditions

Experimental work on carbon injection was conducted on acid-cupola iron in 800-, 1200-, and 2000-lb horizontal cylindrical crane ladles in a large foundry. A batch feeder was used in these tests with 9 to 12 in. of immersion of the injection tube. Some of the irons were plain and others contained alloys. Runs were made to determine the effects of feed rate of carbon, the quantity of carbon injected, and the particle size. It was found that for injection periods of less than four minutes, up to 0.48 per cent C was picked up by the cast iron in a 2000-lb ladle at 2600 to 2700 F.

Table 3 summarizes representative date of the heats made at this foundry. It may be seen that these data show approximately a 50 per cent recovery of carbon. The efficiency was found to be relatively insensitive to the variables mentioned above, within the range of conditions of these tests.

In another large foundry, carbon injections were carried out in 3500-lb ladles, using a batch feeder with 18 in. of immersion of the injection tube. Irons from both acid and basic cupolas were treated. Table 4 summarizes representative data of the heats made at this foundry. These results show a somewhat higher efficiency of carbon recovery than those of Table 3. This can probably be explained by the greater depth of immersion, the lower initial carbon equivalents of these irons, and other factors.

### Effect on Mechanical Properties

Two important questions arise regarding irons into which carbon has been injected. First, is the quality of the iron so produced equivalent to that of normal irons? Second, are the properties at a given composition comparable to irons made by normal methods?

One criterion used in this paper to compare gray iron properties is the well-known MacKenzie relationship[4] involving the tensile strength and Brinell hardness. The equation of this expression is $T = 1.82B^{1.85}$ where $T$ is the tensile strength in pounds per square inch and $B$ is the Brinell hardness. At any given strength level, if the iron is appreciably harder than indicated by the MacKenzie relationship, the iron is usually less desirable. If it is appreciably softer, the iron is considered better. The latter condition is brought about frequently by judicious inoculation treatments.

The other criterion is the relationship between ultimate tensile strength and the carbon equivalent. Many investigators[5, 6] have studied this behavior for different sized sand cast bars.

Fig. 1 shows the tensile-Brinell relationship for 71 heats of unalloyed iron made in a 500-lb high-frequency induction furnace at the authors' laboratories and 22 heats made in a similar type furnace by Burgess and Bishop.[7] None of these was alloyed or inoculated. It is evident that at Brinell hardness levels above about 180, uninoculated in-

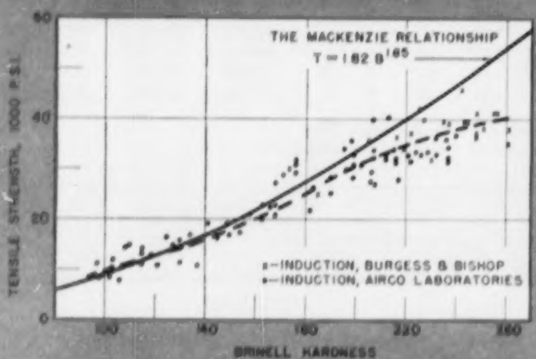



Fig. 1 . . Vary from MacKenzie above 180 Bhn.

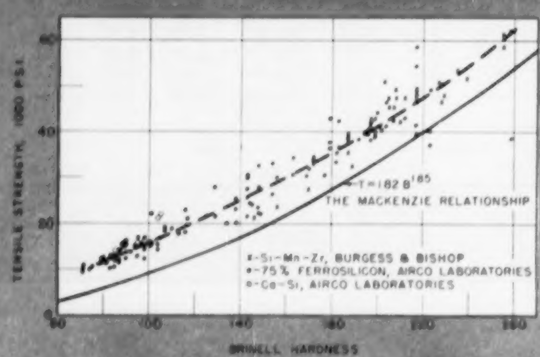



Fig. 2 . . Strength raised 5000 to 7000 psi.

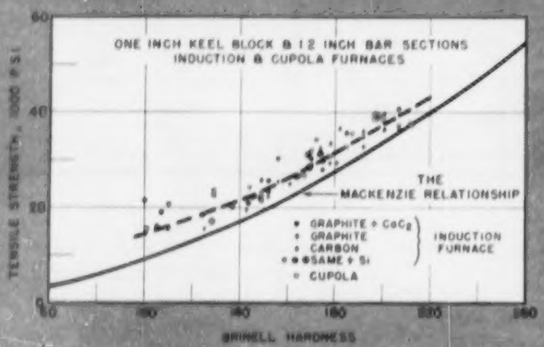



Fig. 3 . . Carbon injection increases tensiles.

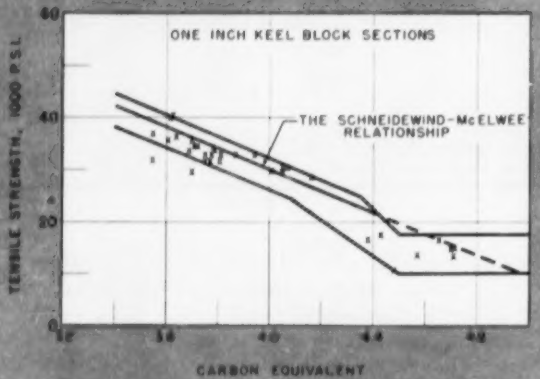



Fig. 4 . . Low CE irons respond to inoculation.

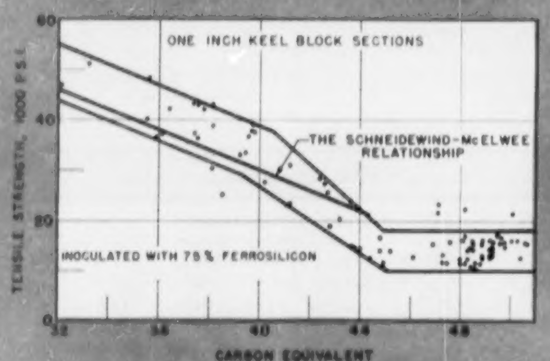



Fig. 5 . . Tensile has been raised about 7000 psi.

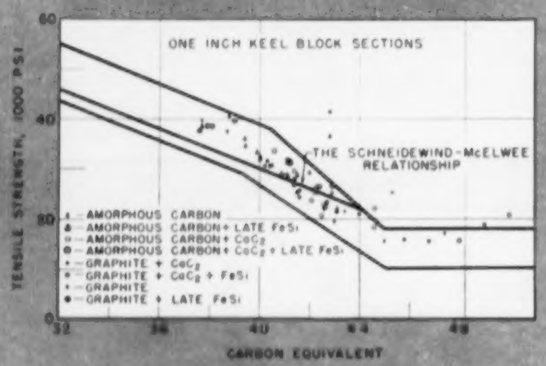



Fig. 6 . . Irons injected with 0.2-1.2% carbon.

duction heats deviate unfavorably from the MacKenzie average.

Figure 2 presents the strength-hardness relationship for a group of inoculated, unalloyed irons. Of these, 97 were melted in a high-frequency induction furnace and inoculated with 75 per cent ferrosilicon; six were melted in an induction furnace and inoculated with calcium silicide; and 36 were melted in an induction furnace and treated with an alloy containing silicon, manganese, and zirconium. The last group was reported by Burgess and Bishop.[7] The results indicate that inoculation raises the strength level on an average from 5000 to 7000 psi at all hardness values from 70 to 260 Brinell. Comparison of Fig. 1 and 2 leads to the conclusion that harder irons benefit most by ladle inoculation.

Figure 3 was prepared to determine the strength-hardness relationship for irons into which carbon had been injected. The amounts of carbon added in these heats varied from less than 0.2 per cent to over 1.2 per cent. In some cases carbon was the only material used and in others a mixture of carbon and calcium carbide was used. Some heats were inoculated with late ferrosilicon after carbon injection, and some were not inoculated. The twelve foundry ladles were obtained from a balanced-blast acid-lined cupola and inoculated with 75 per cent ferrosilicon. An analysis of these data shows that there is little difference between the various treatments; all four treatments give somewhat higher tensile strengths for a given hardness than is predicted by the MacKenzie relationship.

### Higher Strength Results

Comparison with Fig. 1 and 2 leads to the conclusion that irons to which appreciable amounts of carbon have been added by injection have higher strength to hardness ratios than irons in which the carbon content was obtained by normal charge practice. Irons which have been injected with carbon behave more like ferrosilicon inoculated irons. Also, there appears to be practically no difference in properties between inoculated induction furnace irons and good cupola irons.

The second question is to determine whether or not the properties of a given composition are comparable to irons made by normal methods. Figure 4 is a plot of the tensile strength of 1-in. keel block sections of irons melted in a 500-lb induction furnace as related to the carbon equivalent, i.e., $\%C + \frac{\%Si + \%P}{3}$. Limit lines have been drawn enclosing most of the points. As a guide, a predicted strength line was drawn for a 2-in. round bar according to the Schneidewind and McElwee[5] relationship. This bar size was chosen because cooling curve data indicated that 1-in. keel blocks cool from the molten condition similarly to a 2-in. round bar.

The plot shows that the strengths at the lower carbon equivalents are lower than predicted by the Schneidewind-McElwee relationship.[5] This behavior has previously been observed in unalloyed, uninoculated irons melted in induction furnaces. Such irons should respond well to inoculants. As the eutectic is approached, the irons behaved more normally. The as-melted hypereutectic irons are all quite weak, whether inoculated or not.

Figure 5 presents data on keel block sections of induction-melted gray irons which have been inoculated with 75 per cent ferrosilicon or, in a few instances, with calcium silicide. The upper limit line has been raised approximately 7000 psi by inoculation. The data in the 4.0 to 4.3 carbon equivalent range do not show the same straight line relationship as developed by Schneidewind and McElwee;[5] rather they are in agreement with the data of Angus, Dunn, and Marles[6] for 1.6- and 2.1-in. bars.

### Equivalent to Cupola Irons

Figure 6 summarizes the data on irons which have acquired 0.2 to over 1.2 per cent supplemental carbon by injection. The values fit quite well within the same limit lines as for the inoculated irons shown in Fig. 5, although the scatter of points is less, indicating greater uniformity in properties.

Figure 7 was prepared with the same limit lines, dotted, as in Fig. 5. Tensile data from 1.2-in. diam. bars were plotted for:

1. Irons poured from an acid-lined cupola and inoculated with silicon
2. The same irons poured after injection with various quantities of carbon
3. Induction-melted irons inoculated with a silicon-manganese-zirconium alloy reported by Burgess and Bishop.[7]

The solid lines, which enclose all the points for 1.2-in. bars, are on the average 3000 psi higher than the dotted ones for 1-in. keel-block sections. Here again the carbon injected irons show strengths which are equivalent to the inoculated irons.

The conclusions to be drawn from Figs. 4 to 7 are that irons melted in the cupola or high-frequency induction furnace and to which appreciable amounts of carbon have been added by injection are equivalent to normal cupola irons which have been suitably inoculated. Also, on the basis of composition, there seems to be practically no difference between cupola irons and induction irons after inoculation.

### Microstructure Comparisons

Metallographic examinations were conducted on the 59 heats plotted in Fig. 6. These heats were made in the laboratory in a high-frequency induction furnace and poured into 1-in. keel blocks. Structures of the 10 heats reported in Fig. 7, which were melted in a foundry using a balanced-blast acid-lined cupola, were similarly studied. All heats were treated with injected carbon, either alone or in combination with calcium carbide or ferrosilicon or both. The compositions covered a wide range, from a carbon equivalent of 3.7 to 5.0.

The graphite pattern was found to be predominantly Type A, as is shown in the following summary:

| Graphite Type | Number of Heats | Per cent of Heats |
|---|---|---|
| A | 64* | 92.75 |
| B | 1 | 1.45 |
| C | 2 | 2.90 |
| D | 2 | 2.90 |
| E | 0* | 0 |

* In some cases Type E graphite was found as a minor part of the graphite structure mixed with Type A.

These findings indicate a pronounced tendency for injected carbon to produce Type A graphite in a large number of runs having a wide range of composition.

The matrix studies revealed an unexpected degree of pearlite stability in carbon-injected irons. The following summary is presented showing the matrix structures in 1-in. keel block sections made in the laboratory and in 1.2-in. bars made under foundry conditions.

| Pearlite in Matrix, % | Number of Heats | Per cent of Heats |
|---|---|---|
| 100 | 50 | 72.4 |
| 95-99 | 14 | 20.3 |
| 50-60 | 2 | 2.9 |
| 5-10 | 3 | 4.4 |

In the irons containing 95 to 99 per cent pearlite, the ferrite ap-

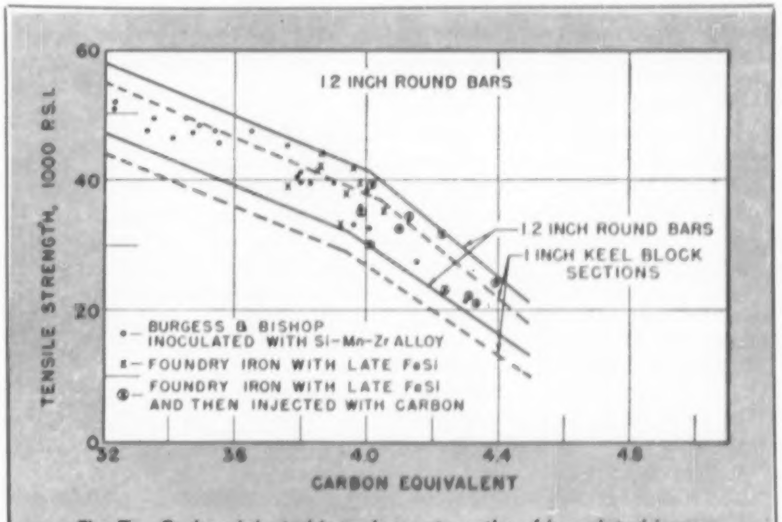



**Fig. 7 . . Carbon injected irons have strengths of inoculated irons.**

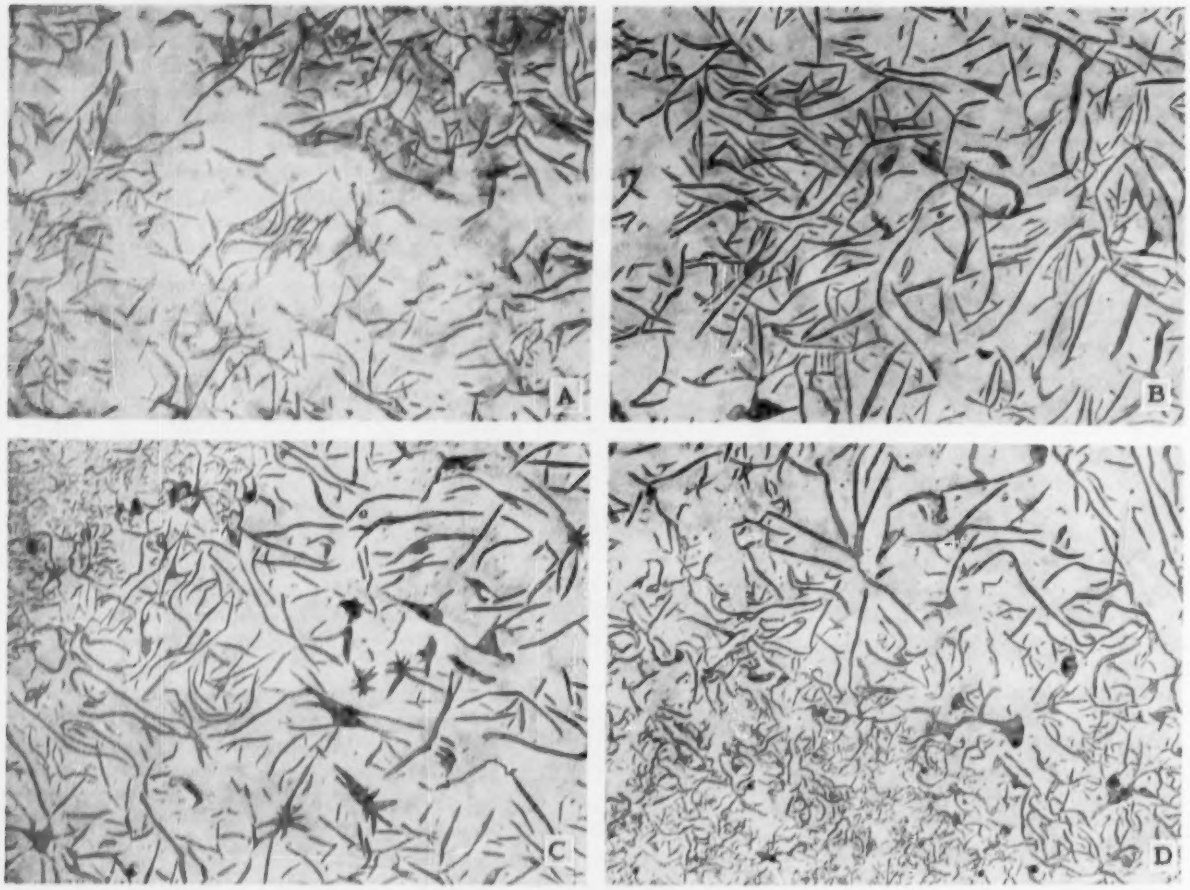



**Fig. 8 . . Structures of carbon injected irons (Table 5) Type A graphite, 98-100% pearlitic, 2% Nital etch, 100X.**

peared at the edges of Type A graphite rather than concentrated in patches of Type D graphite. This is unusual in that ferrite is frequently assocated with Type D graphite in poorly inoculated irons, and at the corners of castings. Of the five heats in which 50 per cent or more ferrite was found, three of the irons contained only 0.22 per cent Mn and the other two had carbon equivalents approaching 5.0.

The pearlitic structure was found even for samples which had low Brinell hardness and low tensile strength. Table 5 presents data showing this effect. The heats made in the laboratory had been desulfurized with calcium carbide simultaneously with carbon injection. The foundry irons were injected with carbon alone. It is to be noted that pearlitic structures were produced even when the Brinell hardness was 143 and when the irons were eutectic or hypereutectic, and the cooling rate was as slow as that of a 1-in. keel block. Inoculation with silicon did not alter this behavior.

The structures of the irons reported in Table 5 are shown etched, at 100 magnification, in Fig. 8.

### Effect on Chill

Data in Tables 1 to 4 show excellent reduction in chill for all irons injected with carbon. Part of this reduction in chill can be ascribed to the over-all change in composition; however, the change in composition cannot account completely for the remarkably low chills found in irons such as No. 6, and No. 14, Table 3. The change in chill of the No. 6 iron from 2/32 to 1/32 by carbon injection is probably more significant than the much larger chill reduction from 9/32 to 2/32 for the No. 14 iron. Furthermore, it should be emphasized that these chill reductions were obtained after the chill had already been reduced by late ferrosilicon additions.

### Significance of Carbon Injection

The experimental work done in the laboratory and in the foundry leads to the following tentative conclusions:

1. Carbon can be introduced into molten iron in a ladle or forehearth by the injection process. Substantial and uniform increases in carbon can be attained from heat to heat by injection periods consistent with foundry production procedures. This practice allows additional control of carbon content outside of the cupola and permits the use of one base iron composition which can be altered at will by injection in the ladle to suit any particular casting.

2. Calcium carbide can be injected simultaneously with carbon if it is desired to desulfurize at the same time. This combination makes possible the production of a 3.60 per cent C, low sulfur iron for nodular iron from a standard 3.30 per cent C, 0.10 per cent S cupola iron. Irons produced by this process are at least equal to those made in a basic cupola for nodulizing.

3. Carbon-injected irons behave as normal gray irons with respect to the relationship of tensile strength with Brinell hardness and composition.

4. Carbon-injected irons are equivalent in strength to inoculated irons. The tendency toward formation of Type D and graphite is low.

5. Completely pearlitic matrices have been produced in hypoeutetic and hypereutectic compositions in keel block sections even when the Brinell hardness was as low as 143; this may be of interest where easy machining and wear resistance are desired.

6. Irons to which carbon has been injected have lower chilling tendency than similar composition irons made by usual methods.

7. Analysis of the data indicates that a greater degree of uniformity and predictability of properties is produced by carbon injection.


### Acknowledgement

The authors wish to express their appreciation for the valuable advice and guidance given by T. W. Curry, Harvey Henderson, and Walter Kelly, Lynchburg Foundry Co., and Dr. A. Muller, Dr. J. M. Parks, P. M. Hulme, and J. M. Crockett, Air Reduction Co., in the development of this process.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# NO NEED FOR RAT-TAILS

**Sand selection, proper mixtures, and controlled ramming help eliminate this costly nuisance**

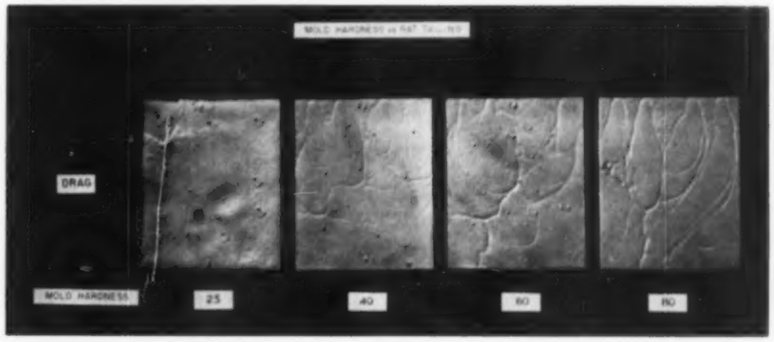



**Fig. 1 . . Rat-tailing severity increases as mold hardness gets higher.**

■ Rat-tail defects need not appear on any casting.

The Committee on Physical Properties of Iron Foundry Molding Materials can make 'em and eliminate 'em. The work of this American Foundrymen's Society committee first appeared in the 1948 and 1949 AFS TRANSACTIONS (vol. 56 and 57) and has continued since then.

The committee found that neither metal pouring temperature nor pouring speed has any influence over the degree of rat-tailing.

### Grain Size Not a Factor

Changes in green compressive strength from 3.8 to 10.1 psi do not influence the degree of rat-tailing.

Using sands of a single screen size, the committee found no apparent difference in rat-tailing for a 40, 50, or a 70 mesh sand.

Then a 100-mesh base sand was used to test the influence of grain distribution. A series of test castings was made in molds of a 3-screen sand distributed equally on one screen on both sides of the 100 mesh screen (on 70, 100, 140). Another series was made with a 5-screen sand on 50, 70, 100, 140, and 200; and still another with a 7-screen sand with 40 and 270 added to the screen spread. The degree of rat-tailing, for all practical purposes, was the same for all grain distributions tested.

### Mold Hardness Effect

The severity of rat-tailing was discovered to increase with an increase in mold hardness (Fig. 1). Reducing mold hardness, however, is not recommended as a means of control as there are other more desirable ways.

Sand tempered to its lightest riddled weight per unit volume produces less rat-tails than sand tempered on the dry or the wet sides.

Figure 2 shows the benefits of adding cereal to the sand mix. With 1.5 per cent addition, no rat-tail defect is noticeable. Since a severe rat-tailing sand was used for the base sand, one can, in practice, use a much lower percentage of cereal binder than shown.

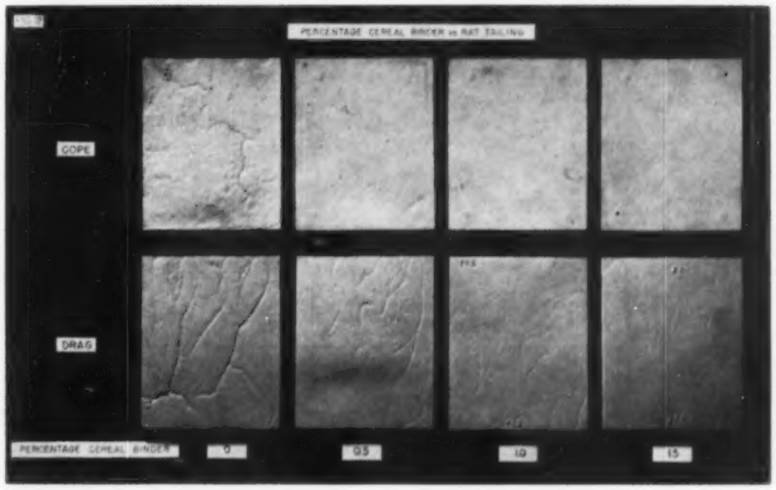



**Fig. 2 . . Cushioning materials reduce expansion, eliminate rat-tails.**

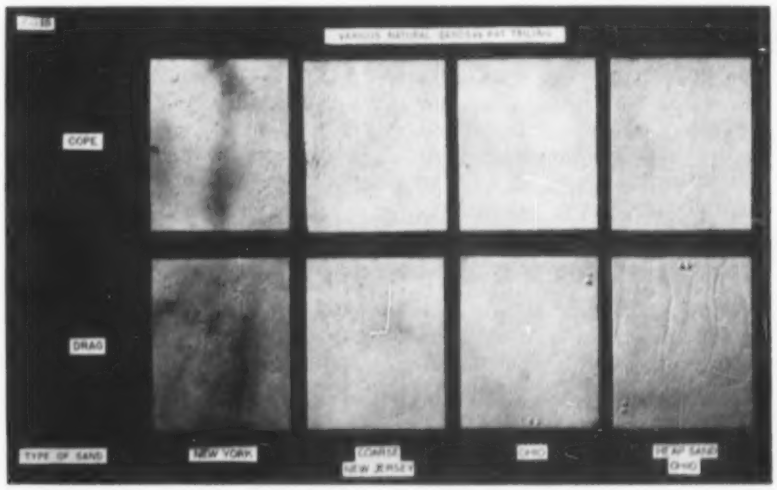



**Fig. 3 . . Some natural sands have less tendency to produce rat-tails.**

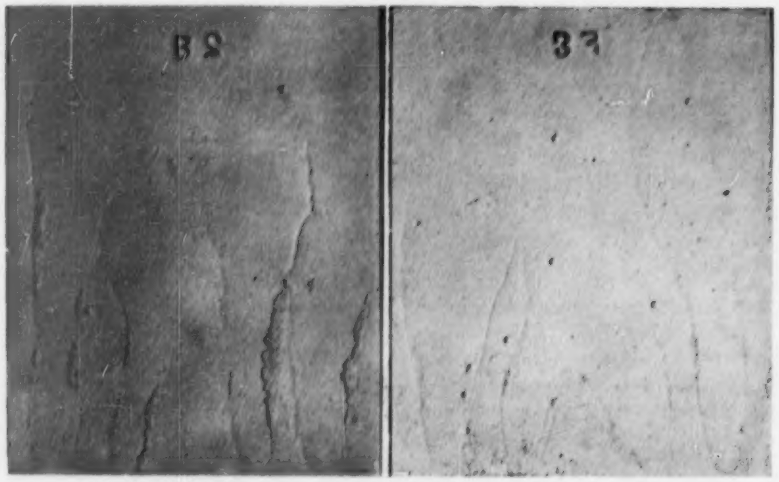



**Fig. 4 . . Production sand lost rat-tailing tendency with 0.5% cereal.**

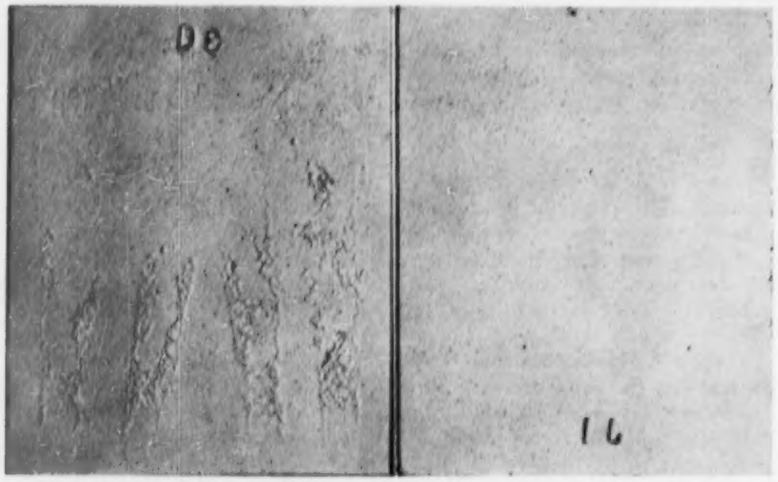



**Fig. 5 . . Rat-tails were eliminated by adding equal parts Albany sand.**

Wood flour and seacoal also prove beneficial. Two per cent of wood flour or five per cent of sea coal reduce the degree of defect of the severe rat-tailing base sand. Again, lower percentages, particularly of wood flour or cellulose material, eliminate rat-tails in most production sands.

### Some Natural Sands Better

As the sands thus far discussed are synthetic it is well to know that certain natural bonded sands are more resistant than others to rat-tailing. Figure 3 shows test castings made with several natural bonded sands under conditions identical to those for synthetic sands.

For further proof of the benefits derived from additives, the committee added various ingredients to production molding sands as received from several foundries.

Production foundry sand *B* produced severe rat-tail defects. When 0.5 per cent of cereal binder was added only faint rat-tail defects remained.

Another production foundry sand *D* produced castings with wide rat-tails which were eliminated by adding equal parts of Albany molding sand.

### Other Correlations

A strong correlation exists between high confined expansion at 2500 F plus high hot compressive strength at 1000 F and rat-tail defects under the committee's method of molding and test casting. (Fig. 6).

A sand with a high confined expansion of, for example, 0.040 in. will require a low hot compressive strength, such as 50 psi to free it of rat-tailing tendencies.

Another sand with a comparatively low confined expansion of 0.020 in. may have a high hot strength of 190 psi and not be conducive to rat-tailing.

### Conclusions

- 1. Hard-rammed molds should be made from sands of low rat-tailing tendencies; i.e., they should have low confined expansion and moderate hot strength.
- 2. Additives such as wood flour, cellulose materials, seacoal, and pitch reduce or eliminate rat-tails.
- 3. Additions of naturally bonded sands possessing low expansion and hot strength reduce or eliminate rat-tails.
- 4. Recent investigations indicate the confined expansion test should be made with slow heating (10 F/min) of the horizontal 1-1/8 x 2-in. specimen in a quartz tube, preferably with a 1/2-in. hole through the specimen for better heating and to avoid breaking the tube. Expansion at 1100 F should be recorded in in./in. of specimen length.
- 5. Hot compressive strength is to be determined on a 1-1/8 x 2-in. sand specimen at 1100 F, shock heating with a soaking period of 12 min and table rise of .1 in./min.

6. Indications that hot deformation test data will correlate with rat-tail tendencies may be investigated by the committee.

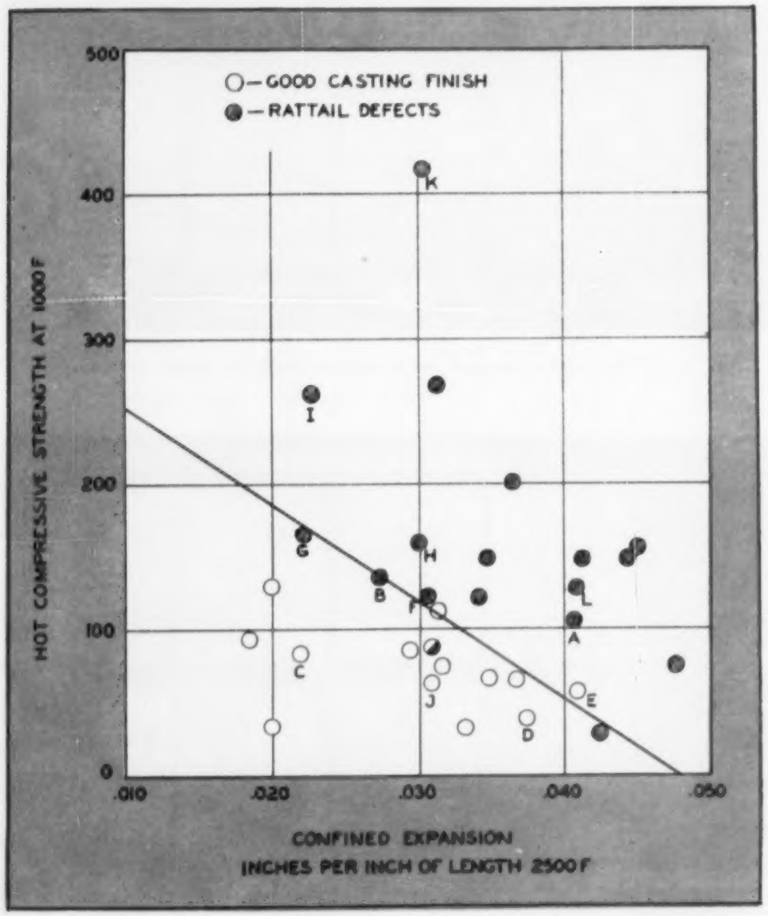



**Fig. 6 . . Hot strength and confined expansion correlate with rat-tailing.**

### How Precise Are Patterns?

■ From a patternmaker's standpoint, a good place to examine casting dimensional tolerances is to discuss the accuracy with which he works.

Considering the pattern medium, accuracy is maintained within surprisingly close limits. Aside from straight error, a patternmaker works within 1/32-in. on small work and usually less than 3/32-in. on large patterns. While these are usual tolerances, closer limits can be enforced in special cases.

Draft is another source of trouble. A good patternmaker is as conscious of draft as a molder. It seldom appears on blueprints, but it must be on the pattern. A nominally ¾ in. thick rib will probably measure only 11/16-in. at the top, and 13/16-in. at the bottom. The designer seems to realize this, but it is sometimes difficult to explain why a casting three feet deep is small on the bottom and large on top.

Major patternmaking headaches are caused by pattern shrinkage and its stepchild—distortion. Except in purely production foundries, by far the largest number of patterns are made of wood, which is subject to dimensional change with any change in moisture conditions.

#### Need Best Materials

The patternmaker tries to minimize pattern shrinkage by using skillful construction and protective coatings, but he must have the best of materials, as no coating prevents warping of improperly seasoned lumber.

Although the patternmaker has a few general rules and tables of contractions, there is no substitute for experience in predicting shrinkage.

He attempts to control casting tolerances by working carefully with a sense of design that balances molding requirements with the engineer's desires—and forty years' experience that enable him to grope a little less blindly in the maze of problems created by that phenomenon called shrinkage.

From a talk by A. E. Wells, pattern foremen, Dominion Engineering Works, Ltd., Lachine, Que., before the Eastern Canada Chapter of the American Foundrymen's Society.

## Metals Casting Conference Program Details Released

■Metals Casting Conference will be held again this year at Purdue University, West Lafayette, Ind., November 3 and 4. Sponsored by the Central Indiana and Michiana Chapters of the American Foundrymen's Society in cooperation with Purdue, the conference has as general chairman J. P. Lentz, International Harvester Co., Indianapolis. R. H. Greenlee, Auto Specialties Mfg. Co. St. Joseph, Mich., is program chairman.

All sessions will be held in the Memorial Union Buliding on the Purdue campus.

THURSDAY, NOVEMBER 3

9:00 am . . Registration
10:00 am . . Welcome. Dr. A. R. Spalding, Purdue University. Industry Response. F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill., AFS Vice-President
*"Fundamentals of Humanics,"* Ralph L. Lee
1:30 pm . . *"Advances in Sand Technology,"* O. Jay Myers, Archer-Daniels-Midland Co., Minneapolis
3:00 pm . . *"Gas in Metals,"* Prof. Norman Parlee, Purdue
6:00 pm . . Banquet. Speaker: Prof. M. B. Ogle, Purdue

FRIDAY, NOVEMBER 4

10:00 am . . *"Principles of Risering,"* C. F. Walton, Gray Iron Founders' Society
11:15 am . . *"Control of Metal in Melting,"* Phillip Semler, Auto Specialties Mfg. Co.
1:30 pm . . *"Molding Sands,"* Earl E. Woodliff, Foundry Sand Service Engineering Co., Detroit
3:00 pm . . Closing Remarks. J. P. Lentz and Prof. C. T. Manek

## Combine Cost-Conscious Units

Close association of industrial engineering and costs in foundries is reflected in the combining of the Cost Committee with the Industrial Engineering Committee of the American Foundrymen's Society. Joseph J. Farkas, Cincinnati Milling Machine Co., Cincinnati, will be chairman of the combined group. Vice-chairman is Everett C. Reid, Ford Motor Co. of Canada, Ltd., Windsor, Ont.

Circle No. 92, page 83-84

# Calculating Casting Weights



■ Determining the amount of metal a contemplated casting will require is always a part of the development of each casting.

If the pattern exists, his is, of course, made easy; however if this is not the case, the estimator must resort to other ways. One method is to figure areas of surfaces and volumes of solids from simple data of lines and angles (called mensuration) and multiply by the weight of metal per unit volume.

The following aids in determining casting weights are developed from the American Foundrymen's Society PATTERN-MAKER'S MANUAL and other sources on mensuration. For the most part, angles and trigonometry are avoided, making for easy calculation without tables, slide rules, calculators, or other references or tools.

### Weigh the Pattern

A simple method for determining the weight of castings from solid patterns or those with easily calculated voids is to weigh the pattern and multiply the weight of the pattern by the casting metal pattern material factor.

### Displacement Method

Cubic displacement of complicated cores can be measured by filling the core boxes with dry sand and measuring the volume of fill in a suitable square box or by weighing. Baked cores can also be sectioned to duplicate the casting voids and then weighed to determine the total casting void. Multiplying the weight of dry sand by 4.5 provides the approximate weight of heavy metal displaced; for aluminum castings multiply the sand weight by 1.5.

### Calculate Casting Sections

Accurate calculation of casting weights requires a breakdown of the design into simple sections such as rounds, cubes, and plates; and the determination of their volumes in cubic inches. The sum of the volumes is then multiplied by the weight of the casting metal per cubic inch as given in the table, "Weight per Cubic Inch."

**Pattern to Cast Metal Conversion Factors**

| Pattern Material | Casting Metal Factors Steel | Iron | Brass | Cu | Zn | Al |
|---|---|---|---|---|---|---|
| Pine | 17.0 | 16.0 | 19.0 | 19.6 | 15.0 | 5.70 |
| Redwood | 17.0 | 16.0 | 19.0 | 19.6 | 15.0 | 5.70 |
| Mahogany | 13.0 | 12.0 | 14.0 | 14.7 | 11.5 | 4.50 |
| Cherry | 11.5 | 10.5 | 12.5 | 13.0 | 10.0 | 3.80 |
| Poplar | 15.0 | 14.0 | 17.0 | 17.5 | 13.0 | 5.00 |
| Walnut | 11.5 | 10.5 | 12.5 | 13.0 | 10.0 | 3.80 |
| Cedar | 19.0 | 18.0 | 21.0 | 21.5 | 17.0 | 6.30 |
| Teak | 13.0 | 12.0 | 14.0 | 14.7 | 11.5 | 4.50 |
| Plaster | 3.2 | 2.85 | 3.3 | 3.44 | 2.7 | 1.10 |
| Aluminum | 3.2 | 2.85 | 3.30 | 3.44 | 2.7 | 1.00 |
| Brass | 1.10 | 0.93 | 1.00 | 1.10 | 0.93 | 0.32 |
| C. I. | 1.08 | 1.00 | 1.08 | ...... | ...... | ...... |

The following symbols are used in figures and formulas of mensuration except where noted.

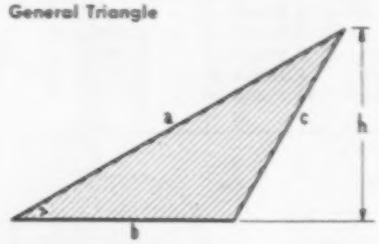
**Nomenclature**

| | |
|---|---|
| a to d | lengths of sides |
| $\alpha, \beta, \gamma$ | angles |
| A | area (total) |
| $A_L$ | area of lateral or convex surface |
| b | (subscript) pertains to base |
| C | lengths of chords |
| D, d | diameters (major & minor) |
| e, f | lengths of diagonals of planes |
| h | height of altitude perpendicular to reference base |
| $h_g$ | vertical height between centers of gravity of two areas of solid |
| j | length of diagonal of solid |
| L | lateral length or slant height |
| m | (subscript) pertains to midsection |
| n | number of sides |
| p | perimeter or circumference |
| R, r | radii (major & minor) |
| r | (subscript) pertains to right sections |
| s | ½ perimeter |
| t | (subscript) pertains to top |
| V | volume |

**Weight per Cubic Inch**

| | lb/in³ | | lb/in.³ |
|---|---|---|---|
| Cast Steel | 0.286 | "G" or "M" Bronze | .315 |
| Cast Iron | 0.260 | Aluminum | 0.091 |
| Brass | 0.296 | Tin | 0.265 |
| Copper | 0.310 | Lead | 0.40 |
| Zinc | 0.260 | Plaster of Paris | 0.0894 |

**General Triangle**

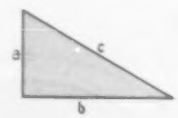


$p = a + b + c$
$s = \frac{1}{2}p = \frac{1}{2}(a + b + c)$
$h = 2/b\sqrt{s(s-a)(s-b)(s-c)}$
$A = \frac{1}{2}bh = \frac{1}{2}ab \sin\gamma$
$= \sqrt{s(s-a)(s-b)(s-c)}$

radius of circle inscribed in any triangle: $r = \dfrac{\sqrt{s(s-a)(s-b)(s-c)}}{s}$

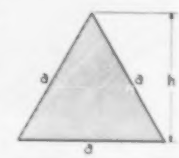
radius of circle circumscribing any triangle: $R = \dfrac{abc}{4\sqrt{s(s-a)(s-b)(s-c)}}$

**Right Triangle**



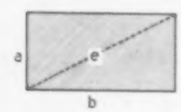
$c^2 = a^2 + b^2$
$b = \sqrt{c^2 - a^2}$
$A = \frac{1}{2}ab$

**Equilateral Triangle**



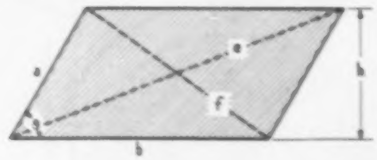
$p = 3a$
$h = \frac{1}{2}a\sqrt{3}$
$= 0.866a$
$A = \frac{1}{4}a^2\sqrt{3}$
$= 0.433a$

**Rectangle**



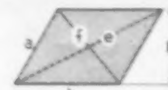
$A = ab$
$e = \sqrt{a^2 + b^2}$

**General Parallelogram or Rhomboid** (opposite sides parallel)



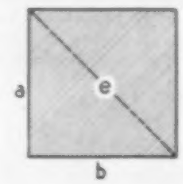
$p = 2(a + b)$
$e^2 + f^2 = 2(a^2 + b^2)$
$A = bh = ab \sin\theta$

**Rhombus** (opposite sides parallel and all sides equal)



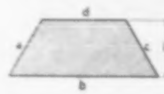
$a = b$
$p = 4a = 4b$
$e^2 + f^2 = 4a^2$
$A = bh = \frac{1}{2}ef$

**Square**



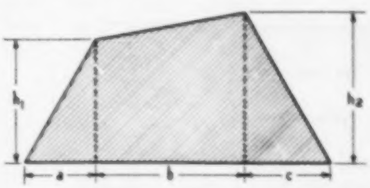
$a = b$
$p = 4a$
$e = a\sqrt{2}$
$A = a^2 = \frac{1}{2}e^2$

**Trapezoid**



$p = a + b + c + d$
$A = \frac{1}{2}(a + b)h$

**Trapezium** (no sides parallel)



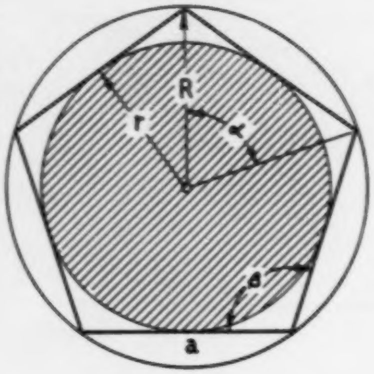
$p =$ sum of four sides
$A = \frac{1}{2}[ah_1 + b(h_1 + h_2) + ch_2]$

# foundry facts

## Calculating Casting Weights



### Regular Polygons




$n$ = number of sides; $a$ = length of one side; $\beta$ = angle between adjacent sides; $\alpha$ = angle included by radii to ends of one side; $r$ = radius of inscribed circle; $R$ = radius of circumscribed circle.

$R = \frac{1}{2} a \csc \frac{180}{n}$ $\qquad r = \frac{1}{2} a \operatorname{ctn} \frac{180}{n}$

$a = 2\sqrt{R^2 - r^2}$ $\qquad p = na$

$A = n$ times area of each triangle formed by radii to ends of sides:

$A = \frac{1}{4} na^2 \operatorname{ctn} \frac{180}{n}$

Polygon inscribing a circle:

$p = 2nR \sin \frac{\pi}{n}$

$A = \frac{1}{2} nR^2 \sin \frac{2\pi}{n} = \frac{1}{2} na\sqrt{R^2 - \frac{1}{4}a^2}$

Polygon circumscribing a circle:

$p = 2nr \tan \frac{\pi}{n}$

$A = \frac{1}{2} nar = nr^2 \tan \frac{\pi}{n}$

Square:

$a = 0.707D$; $D = 1.414a$ = diagonal

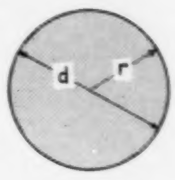
Square-Circle of equal periphery

$d = 1.2732a \qquad a = 0.7854d$

### REGULAR POLYGON OF SIDE "a"

| No. of Sides | Area of Polygon | | |
|---|---|---|---|
| 3 | $0.43303\ a^2$ | = | $5.14862\ r^2$ |
| 4 | $1.00000\ a^2$ | = | $4.00000\ r^2$ |
| 5 | $1.72048\ a^2$ | = | $3.63273\ r^2$ |
| 6 | $2.59808\ a^2$ | = | $3.46408\ r^2$ |
| 7 | $3.63391\ a^2$ | = | $3.37099\ r^2$ |
| 8 | $4.82843\ a^2$ | = | $3.31368\ r^2$ |
| 9 | $6.18182\ a^2$ | = | $3.27574\ r^2$ |
| 10 | $7.69421\ a^2$ | = | $3.24922\ r^2$ |
| 11 | $9.36564\ a^2$ | = | $3.22987\ r^2$ |
| 12 | $11.19615\ a^2$ | = | $3.21539\ r^2$ |

### Circle

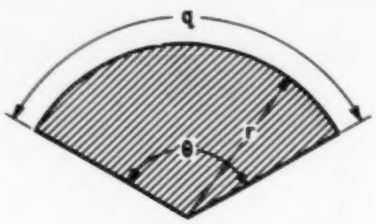



$p = \pi d = 2\pi r$
$= 2\sqrt{\pi A}$
$A = \pi r^2 = \frac{1}{4}\pi d^2$
$= \frac{p^2}{4\pi}$
$= 0.07958p^2$

$d = 2r = \frac{p}{\pi} \qquad = 2\sqrt{\frac{A}{\pi}}$

$r = \frac{1}{2}d = \frac{p}{2\pi} \qquad = \sqrt{\frac{A}{\pi}}$

### Sector



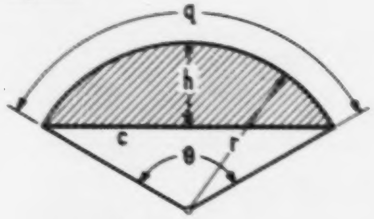

$q = \pi d \frac{\theta}{360} = 2\pi r \frac{\theta}{360} = 0.017533 r\theta$

$A = \frac{1}{2} qr = \pi r^2 \frac{\theta}{360} = 0.0087266 r^2\theta$

$\theta = \frac{180q}{\pi r} = 57.2958\frac{q}{r}$

$p = q + 2r$

### Segment




$r = \frac{(\frac{1}{2}c)^2 + h^2}{2h}$

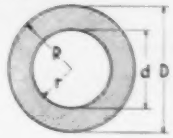
$c = 2\sqrt{h(d - h)} = 2r \sin \frac{1}{2}\theta$

$\frac{1}{2}\theta = 28.6479\frac{q}{r}$; $\sin \frac{1}{2}\theta = \frac{c}{r^2}$

$A = \pi r^2 \frac{\theta}{360} - \frac{1}{2}c(r - h)$
$= \frac{1}{2}[qr - c(r - h)]$
$A = \pi r^2 \frac{\theta}{360} - \frac{1}{2} r^2 \sin \theta$

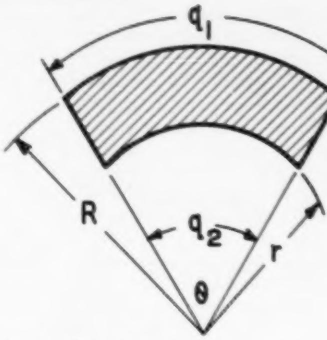
### Circular Ring or Hollow Circle

**Annulus** (when concentric)



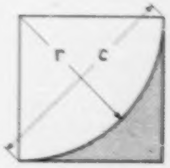

$A = \frac{1}{4}\pi(D^2 - d^2)$
$= \pi(R^2 - r^2)$
$= \frac{1}{4}\pi(D + d)(D - d)$
$= \pi(R + r)(R - r)$

### Annulus Sector




$A = \frac{1}{2}\theta(R + r)\ (R - r)$
$= \frac{1}{2}\theta(R^2 - r^2)$
$= \frac{1}{2}(R - r)\ (q_1 + q_2)$

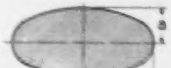
### Fillet or Spandrel




$p = \frac{1}{2}\pi r + 2r$
$A = 0.2146r^2$
$= 0.1073c^2$
$= 1/5r^2$ (approx)

### Ellipse

semiaxes a & b

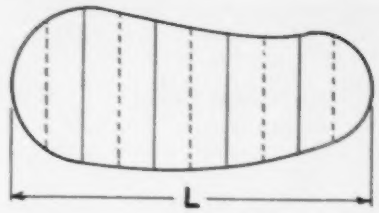



$A = \pi ab$
$p = \pi(a + b)$ (approx)
$= 2\pi\sqrt{\frac{1}{2}(a^2 + b^2)}$ (approx)
$= \pi\ [1.5(a + b) - \sqrt{ab}]$ (more nearly)

### Parabolic Segment


$q = 2\sqrt{b^2 + 4/3h^2}$ (approx)
$A = 4/3\ bh$

### Irregular Figures




To determine approximate area, divide figure into an even number of strips. Multiply the sum of the lengths of dotted lines by the width of the band they divide. The greater the number of strips the more nearly accurate will be the result.

**Continued Next Month**

November Foundry Facts will cover the calculation of volumes of solids with flat and curved surfaces which are then multiplied by the weight of metal per unit volume.

## new books

**Induction and Dielectric Heating . . J. Wesley Cable. vii+576 pp. Reinhold Publishing Corp., 330 West 42nd St., New York 36, N.Y. $12.50.**

Divided into two sections dealing with induction and dielectric heating, respectively. Each section is organized similarly, beginning with a brief discussion of theory, followed by a discussion of the sources of energy, and a number of chapters devoted to specific fields of application such as core baking, induction melting, brazing, and other metallurgical applications of foundry interest.

Mechanization of the equipment for adaptation to the production line is considered in additional chapters. An addendum discusses the problems of radio interference resulting from the use of high-frequency heating equipment.

**Strength and Resistance of Metals . . John M. Lessels. xiv+450 pp. 22 illus. John Wiley Sons, Inc. 440 Fifth Ave., New York 16, N.Y. 1954. $10.00.**

Information on the behavior of metals under stress for advanced students of metallurgy and design engineers. Most of the emphasis is placed on steel but mention is made of non-ferrous alloys and cast iron where their behavior differs from that of steel.

In addition to several chapters on fatigue, other chapters deal with tension, the elastic-stage modification, tensile properties at elevated temperatures, hardness, impact, fracture of metals, strain hysteresis, mechanical wear, and theories of strength and working stresses.

**Product Design—Annual Handbook for 1955 . . 844 pp. Product Engineering, McGraw-Hill Publishing Co., Inc., 330 W. 42nd St., New York 36, N.Y. 3d ed. Included in one year subscription ($5) to Product Engineering.**

One hundred articles on the most significant design engineering developments of the past year, gathered from 62 technical publications (including AMERICAN FOUNDRYMAN) and papers from 41 technical societies.

Sections on general engineering, metals and alloys, non-metallic materials and finishes, fabrication and production processes, power transmission, mechanical parts and design analysis, fastening and joining motors, engines, and controls, electrical and electronic components, and hydraulic and pneumatic equipment.

**ASTM Standards on Gaseous Fuels . . vi+176 pp. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 1954. $2.50.**

Compilation of all ASTM methods of test pertaining to gaseous fuels. Lists members of Committee D-3 on Gaseous Fuels.

**The Dictionary of Business and Industry . . Robert J. Schwartz, ed. xlvi+560 pp. B. C. Forbes & Sons Publishing Co., Inc., 80 Fifth Ave., New York 1, N.Y. 1954. $7.95, with thumb index $8.95.**

Dictionary includes 45,000 business terms, trade names, legal terms, etc., plus charts and tables of coins and notes of the world, foreign weights and measures, weights of materials, foreign trade definitions, and conversion factors.

**Foundrywork for the Amateur . . Terry Aspin. x+93 pp., 86 fig. 12 photo. Percival Marshall & Co., Ltd., 19 and 20 Noel St., London, W 1, England. 1954. 5 shillings.**

Materials and techniques for the amateur foundryman in which emphasis is placed on equipment that can be made in the home workshop. Appendix on sources of materials.

**Directory of Iron and Steel Works in the United States and Canada . . xix+497 pp. American Iron & Steel Institute, 350 Fifth Ave., New York 1, N.Y., 27th ed., 1954. $8.00.**

Lists essential details regarding companies engaged in the iron and steel industry in four sections according to the facilities they operate.

Information not appearing in previous editions includes more detailed data concerning blast furnaces and auxiliary equipment, soaking pits, and heating furnaces.

NANCY PURUCKER, *Librarian*
*American Foundrymen's Society*

## Open 1956 Pattern and Molding Contest

▪ The 1956 Apprentice Contest of the American Foundrymen's Society opens October 3, 1955, with provisions for entry of beginners as well as bona fide apprentices. Competition is open in five divisions: wood patternmaking, metal patternmaking, iron molding (gray iron and malleable), steel molding, and non-ferrous molding.

**First Prize $100**

Prizes awarded for national winners in each of the five divisions are $100, $50 and $25 for first, second and third places, respectively. In addition, the first place winner in each division receives round trip rail and pullman transportation between his home and the convention city where he will receive his award and participate in convention sessions.

In 1956, the AFS Castings Congress and Show will be held May 3 through 9 in Atlantic City.

With the broadening of eligibility regulations beyond bona fide apprentices last year, there were some 365 entries representing 138 companies and 14 AFS chapters in the United States and Canada. The revised regulations specify that the term apprentice shall, for purposes of the competition, be understood to mean a learner or trainee in the all-around practices of the foundry trade who has not had over five years' experience in the pattern trade nor more than four years in the foundry trade.

Students of trade, vocational or high schools are eligible to enter local chapter contests at the discretion of the chapter involved Such entries, if successful in chapter competition, will be considered on an equal basis with regularly enrolled apprentice entries. Amount of training completed has no bearing on eligibility for the contest and is not considered in the judging.

> Full information on the 1956 AFS Apprentice Contest can be obtained from chapter educational committee chairmen or from A. B. Sinnett, Assistant Secretary, American Foundrymen's Society, Golf & Wolf Roads, Des Plaines, Ill.

Membership in AFS on the part of an apprentice or his company is not an eligibility requirement.

All local foundry groups, companies, and interested persons are invited by the AFS Apprentice Contest Committee to develop local contests, or to enter individual local entries directly in the national competition. In the case of local contests, or an apprentice class from a company not in a local contest area, the first, second and third place winners in each division are sent to the national judging. In the absence of a local contest individuals may enter directly in the national competition.

The AFS Apprentice Contest offers a young man recognition and advancement in his chosen trade as well as the opportunity to learn through participation.

## Reveal Northwest Conference Program

▪Scrap diagnosis, sand technology, refractories and casting design will combine with gating and risering, quality control, and an address, *"Frontiers of the Foundry Industry,"* to round out a two-day program of technical papers and AFS Casting Clinic sessions during the Northwest Regional Foundry Conference. To be held October 14 and 15 at the Multnomah Hotel, Portland, Ore., the conference is sponsored by the Oregon, Washington and British Columbia Chapters of the American Foundrymen's Society and the Oregon State College Student Chapter.

**James T. Dorigan**

Other program features are a banquet and dance the evening of October 14, and a special ladies program with brunch followed by shopping tours at 11:00 a.m. on the 14th.

James T. Dorigan, Electric Steel Foundry Co., Portland, is general conference chairman and program chairman.

FRIDAY, OCTOBER 14

9:00 a.m. . . AFS CASTING CLINIC. Hans J. Heine, AFS Technical Director, Clyde A. Sanders, American Colloid Co., Chicago, O. Jay Myers. Archer-Daniels-Midland Co., Minneapolis, and Harry Czyzewski, Metallurgical Engineers, Inc., Portland

*"Casting Design"* . . . Fundamentals of Good Casting Design . . . Conversion to Castings . . . Redesign for Better Castings . . . Product Development

*"Gating and Risering"* . . . Fundamentals of Good Gating Design . . . AFS Color-Sound Movie *"Effect of Gating Design on Casting Quality"*

12:00 noon . . LUNCHEON. *"Frontiers of the Foundry Industry,"* R. W. deWeese, Electric Steel Foundry Co.

1:45 p.m. . . CASTING CLINIC. . *"Principles of Molding Sand Technology,"* Clyde A. Sanders. . . Components of Molding Sand . . . Properties of Molding Sand . . . Core Sand

6:30 p.m. . . RECEPTION

7:00 p.m. . . BANQUET AND DANCE

SATURDAY, OCTOBER 15

9:30 a.m. . . *"Scrap Diagnosis—Causes and Cures,"* Clyde A. Sanders . . . Ferrous Castings . . . Non-Ferrous Castings . . . Group Discussion

12:00 noon . . LUNCHEON. Speaker: Dr. J. G. Jensen, Oregon State College

1:45 p.m. . . *"Basic Refractories,"* J. C. Hicks, Kaiser Aluminum & Chemical Sales, Inc.

*"Electric Furnace Refractories,"* C. E. Grigsby, General Refractories Co.

REFRACTORY ROUND TABLE

## To Study Industrial Relations At NFA Annual Meeting

■ Industrial relations trends of the past year will be mirrored in many of the sessions scheduled for the 57th annual meeting of the National Foundry Association at the Edgewater Beach Hotel, Chicago, October 6 and 7. Patterned to permit foundry management to analyze these trends, the program also includes a report by NFA President W. W. C. Ball, Taylor & Fenn Co., Windsor, Conn., and election of officers.

An "alumni" dinner will be held the evening of October 5.

W. W. C. Ball

At the dinner, attended by past officers and members of the organization's Administrative Council, special recognition will be accorded 26 companies that have been NFA members for over 50 years. Five of the companies—Acme Foundry Corp., Cleveland, Aeromotor Co., Chicago, Erie City Iron Works, Erie, Pa., Straight Line Foundry & Machine Corp., Syracuse, N. Y., and Florence Pipe Foundry & Machine Co., Florence, N. J.— have been members since 1898 when the association was founded.

THURSDAY, OCTOBER 6

9:00 am . . Call to order. Invocation

9:05 am . . Report of the President, W. W. C. Ball

9:30 am . . *"Preparation for Arbitration,"* Clarence Updegraff, University of Iowa

10:30 am . . *"You Are There at the Bargaining Table,"* motion picture of actual bargaining session, completely unrehearsed

12:00 noon . . Luncheon. *"Behind the U.N. Front,"* Alice Widener, publisher and Editor, *U.S.A.*

2:00 pm . . Panel Discussion. *"Group or Individual Company Bargaining?"*

4:00 pm . . Report of Resolutions Committee. Installation of Officers

6:30 pm . . Reception

FRIDAY, OCTOBER 7

9:15 am . . Call to Order

9:30 am . . Panel Discussion. *"The Role of the Foreman in the Foundry,"* C. A. Carolin, R. B. Carolin Foundry & Machine Co., Detroit, A. G. Hall, Nordberg Mfg. Co., Milwaukee, W. E. Jones, Josam Products Co., Michigan City, Ind., and J. D. McGill, U. S. Pipe & Foundry Co., Birmingham, Ala.

12:00 noon . . Luncheon. *"Man in Action—Man in Contemplation,"* Dr. Houston Cole, President, Alabama State Teachers College, Jacksonville, Ala.

2:00 pm . . Panel Discussion. *"Effect of GAW (or SUB) Settlements on the Foundry Industry,"* Karlton W. Pierce, Ford Motor Co., Dearborn, Mich., Floyd Lawrence, Detroit Editor, *Steel*, Robert L. Schutt, Investment Counselor and Economic Analyst, City National Bank & Trust Co., Chicago, Joseph Daoust, Actuary and Pension Consultant, Morss, Seal & Daoust, Detroit, and James I. Poole, Labor Attorney, Fairchild, Foley & Sammond, Milwaukee.

4:30 pm . . Adjournment

## Schedule Syracuse Regional

Seven chapters of the American Foundrymen's Society are working together on the New York State-Canada-Pennsylvania Regional Foundry Conference scheduled for November 18 and 19 at the Onondaga Hotel, Syracuse, N. Y. Coordinating the program are E. G. White, Crouse-Hinds Co., Syracuse, general conference chairman, and James O. Ochsner, Crouse-Hinds Co., program chairman.

Sponsoring groups are the Central New York, Eastern Canada, Eastern New York, Rochester, Western New York, Northwestern Pennsylvania, and Ontario Chapters of AFS.

Sessions scheduled include: a talk and demonstration of the $CO_2$ process of making cores; a pattern panel session covering production foundry requirements, design and use, and purchasing; sectional meetings on risering gray iron, gating and risering of brass and aluminum alloys, paper on steel, sand fundamentals, casting defects, dielectric core baking, insulated risers, production of pearlitic malleable iron, and the AFS color-sound film on vertical gating systems.

It's easy to obtain product data with the postage-free Reader Service Cards provided on pages 83-84. Use them for information on advertised products, too. Just circle the key number appearing at bottom of the ad.

## casting through the ages

# "Better Castings" Is Ohio Meeting Theme

■ How to make "Better Castings for Better Living" will be outlined at the Ohio Regional Foundry Conference to be held October 20-21 at Case Institute of Technology in Cleveland. Sponsoring chapters of the American Foundrymen's Society are Central Ohio, Canton District, Cincinnati District, Northeastern Ohio and Toledo.

The two-day series of 18 technical talks and discussions is under the general chairmanship of Lewis

**L. T. Crosby**

T. Crosby, Sterling Wheelbarrow Co. Program chairman is Alexander D. Barczak, Superior Foundry, Inc.

Registration, all sessions and luncheons will be held in Tomlinson Hall on the Case campus. Conference dinner the evening of Thursday October 20 will be in nearby Tudor Arms Hotel.

Sessions cover a wide range of foundry topics in the fields of gray iron, malleable, steel and non-ferrous, as well as patternmaking.

THURSDAY, OCTOBER 20

9:00 am . . REGISTRATION. Tomlinson Hall, Case Institute of Technology

10:00 am . . WELCOME ADDRESS, T. Keith Glennan, President of Case

GENERAL SESSION. *"Applied Research and Development in the Foundry Industry,"* T. W. Curry, Lynchburg Foundry Co., Lynchburg, Va.

12:15 pm . . LUNCHEON. *"AFS Highlights"*

2:00 pm . . SECTIONAL MEETINGS

Gray Iron . . *"Shell Molding and Shell Cores,"* William J. White, Shallway Corp., Connellsville, Pa.

Malleable . . *"Safety,"* A. C. Hensel, Albion Malleable Iron Co., Albion, Mich.

Steel . . *"Steel Castings vs. Forgings,"* John B. Caine, Consultant, Wyoming, Ohio.

Non-Ferrous . . *"Elimination of the Most Common Defects Found in a Non-Ferrous Foundry,"* Wm. M. Ball, Jr., R. Lavin & Sons, Chicago

3:30 pm . . SECTIONAL MEETINGS

Gray Iron . . *"Cupola Operation,"* Karl G. Presser, Gray Iron Research Institute, Columbus, Ohio

Malleable . . *"Refractories for Malleable Melting and Annealing,"* R. A. Witschey, A. P. Green Fire Brick Co., Chicago

Steel . . *"Melting Practice for Quality Steel Castings,"* Arthur F. Gross, Ohio Steel Foundry Co., Springfield, Ohio

Non-Ferrous . . *"Some New and Different Ideas Pertaining to Non-Ferrous Synthetic Sands,"* Wm. M. Ball III, Hill & Griffith Co., Cincinnati and George Schultz, Allis-Chalmers Mfg. Co., Norwood, Ohio

6:00 pm . . RECEPTION. Tudor Arms Hotel

7:00 pm . . BANQUET. Speaker: P. R. Reid, Ford Motor Co., Detroit

FRIDAY, OCTOBER 21

8:30 am . . REGISTRATION

9:00 am . . SECTIONAL MEETINGS

Gray Iron . . *"High Pressure Molding,"* T. E. Barlow, Eastern Clay Products Dept., International Minerals & Chemicals Corp.

Malleable . . *"Casting Defects,"* Emil Romans, National Malleable & Steel Castings Co., Cleveland

Steel . . *"Practical Application of Riser Calculations,"* H. F. Bishop, Naval Research Laboratory, Washington, D.C.

Non-Ferrous . . *"Gating and Risering of Non-Ferrous Castings,"* Charles V. Knobeloch, R. Lavin & Sons, Baltimore, Md.

10:30 pm . . SECTIONAL MEETINGS

Gray Iron . . *"Exothermic and Insulating Materials,"* Michael Bock II, Exomet, Inc., Conneaut, Ohio

Malleable . . *"Cleaning Malleable Iron Castings,"* E. M. Strick, Erie Malleable Iron Co., Erie, Pa.

Steel . . *"Practical Applications of Moldable Exothermic Compounds in Steel Foundries,"* J. E. Gotheridge, Foundry Services Inc., Columbus, Ohio

Non-Ferrous . . *"The $CO_2$ Process,"* J. Reedy, Delhi Foundry Sand Co.

12:15 pm . . LUNCHEON. *"Something New in Communications,"* R. Clark, Bell Telephone Co., Cleveland

2:00 pm . . GENERAL SESSION. *"Pattern Making,"* George W. Schuller, Jr., Caterpillar Tractor Co., Peoria, Ill.

## Gray Iron Program Features Costs and Labor Relations

■ Markets, costs, labor relations and safety talks will highlight the 27th annual meeting of the Gray Iron Founders' Society October 19-21 at the Hotel Schroeder, Milwaukee. GIFS President Charles H. Ker, Dalton Foundries, Warsaw, Ind., will be honored at a reception and dinner open to all the evening of October 19 and the annual banquet will be held the following evening. Luncheons are planned the 20th and 21st with presentation of new officers and di-

C. H. Ker

rectors, citations and awards, and Redesign Contest awards on the 21st.

A program for the ladies includes luncheons and dinners and a day at the Tripoli Country Club.

WEDNESDAY, OCTOBER 19

9:30 am . . MEETING OF RETIRING BOARD OF DIRECTORS
6:30 pm . . PRESIDENT'S RECEPTION, DINNER AND ENTERTAINMENT, Wisconsin Club

THURSDAY, OCTOBER 20

8:00 am . . REGISTRATION
9:30 am . . ANNUAL BUSINESS Meeting
Report of the President, Charles H. Ker
Report of the Treasurer, Walter O. Larson, W. O. Larson Foundry Co., Grafton, Ohio
Report of the Executive Vice-President, Donald H. Workman
Report of the Technical Director, Charles F. Walton
COMMITTEE REPORTS
11:00 am . . *"Final Report of Program Evaluation Committee,"* C. R.

*continued on page 78*

Culling, Carondelet Foundry Co., St. Louis

12:30 pm . . INDUSTRY LUNCHEON. Presentation of Retiring Board of Directors. Speaker: The Honorable Carl Oechsle, Deputy Assistant Secretary of Commerce for Domestic Affairs, U. S. Department of Commerce

2:00 pm. . PANEL DISCUSSION. *"How We Can Expand Our Markets,"* Dr. Ira D. Anderson, President, American Marketing Association, Robert J. Eggert, Ford Motor Co., and Bay E. Estes, U. S. Steel Corp.

4:15 pm . . COMMITTEE MEETINGS

7:30 pm . . INDUSTRY BANQUET AND ENTERTAINMENT

FRIDAY, OCTOBER 21

8:00 am . . REGISTRATION

9:30 am . . *"The Top Executive Looks at Safety,"* Clifford L. Chatterton, Liberty Mutual Insurance Co., Pittsburgh, Pa.

*"The GIFS Cost Program in Canada,"* Robert B. Hill, Canada Iron Foundries, Ltd., Montreal, Que.

*"1955—a Most Historical Year in Labor Relations,"* Lee C. Shaw, Seyfarth, Shaw & Fairweather

12:30 pm . . INDUSTRY LUNCHEON. Presentation of New Officers and Directors, of 1955 Citations and Awards, and the 1955 Resdesign Contest Awards. Speaker: Major Norman Imrie, Smith Agricultural Chemical Co., Columbus, Ohio

2:30 pm . . ADJOURNMENT

SATURDAY, OCTOBER 22

9:30 am . . MEETING OF NEW BOARD

### Name Alternate Directors

Alternate directors of most of the districts of the Non-Ferrous Founders' Society have been selected. They are: Elmer Brumund, Brumund Foundry, Chicago; Dan T. Wellman, Wellman Bronze & Aluminum Co., Cleveland; Alexander M. Cadman, Jr., A. W. Cadman Mfg. Co., Pittsburgh, Pa.; William Grimm, Philadelphia; Frank G. Volpe, Somerville Machine & Foundry Co., Somerville, Mass.; J. H. Sorensen, Columbus Foundry Co., Brooklyn, N. Y.; Wallace Jones, Jr., James Jones Co., El Monte, Calif.; C. H. Attwood, Attwood Brass Works, Grand Rapids, Mich.; and Walter Huffman, OPW Corp., Cincinnati.

## let's get personal

continued from page 29

**Herbert Geittman, Jr.,** has joined the Metallurgical Development Div., Climax Molybdenum Co., as a cast iron specialist. He was previously foundry manager of Richmond Foundry & Mfg. Co.

**Admiral Alan G. Kirk,** chairman of the board and president of the Mercast Corp., New York, has also been elected president of Alloy Precision Castings Co., Cleveland, following the resignation of **Ronald D. Gumbert.** He will continue to serve as chairman of the board of Alloy, a subsidiary of Mercast.

**Frank W. Glaser** was appointed general manager of Alloy. He will continue in his role of vice-president. Admiral Kirk announced a proposed move of facilities by Alloy Precision from its present quarters to a new and larger plant on Cleveland's west side. Research and development work and certain pilot plant operations are being carried out at the new plant with production facilities to be moved within the next year.

**Robert Krogh** has been appointed sales manager for Ipsen Industries, Inc., Rockford, Ill. **Donald E. Wingate** was named chief engineer.

**Frank Clark** has been appointed an ingot sales representative for the Samuel Greenfield Co., Inc., of Buffalo, N. Y., and **Stephen Stillwell,** formerly of Jamestown, N. Y., has been named a sales representative. His office will be in Cincinnati.

**John L. Lowe,** formerly with the Buick Motors Div., General Motors Corp., has been appointed an instructor at General Motors Institute, Flint, Mich. Mr. Lowe is in the Metallurgy and Foundry Section of the Science Dept.

**George E. Brandon,** general manager, Semet-Solvay Div., Allied Chemical & Dye Corp., New York,

has retired. He had been with Semet-Solvay for 38 years.

R. J. Young

After 42 years of continuous foundry work, **R. J. Young, assistant superintendent** of foundries, Dominion Engineering Works, Ltd., Montreal, has retired. He went to Dominion Engineering Works in 1948 to install and start a steel foundry in a small addition to their iron foundry with a capacity of 200 tons per month, and as of March 1955, opened a complete semi-mechanized new steel foundry with a capacity of 800 tons per month. He has served as a director and vice-chairman of the educational committee of the Eastern Canada Chapter of the American Foundrymen's Society.

**Ray Quadt,** director of research and development of Hunter Douglas Corp., Riverside, Cal., has been promoted to assistant vice-president.

**Norbert K. Koebel** has been appointed manager of the Heat Treating Furnace Div., Lindberg Engineering Co., Chicago.

**Albert S. Telkins** has been appointed district manager of the Philadelphia office of Rotor Tool Co. Cleveland.

**Goff Smith,** manager of Railway Specialties Sales, has been named executive vice-president of Griffin Wheel Co., a subsidiary of American Steel Foundries, Chicago. **Roger G. Kimber** will succeed Mr. Smith as manager of Railway Specialties Sales for the parent company.

 CIRCLE NO. 117, PAGE 83-84

**Paul Licau,** a patternmaker in Allis-Chalmers' West Allis Works, has compiled a patternmaking history that few can equal. He has been a patternmaker for 63 years and has been with Allis-Chalmers more than 55 years. Mr. Licau says that he would do it all over again if he had the chance and that he would like to do it for another 25 years. Mr. Licau has just celebrated his 83rd birthday.

**C. M. Williams** will be in charge of the new Chicago sales office of Lithium Corp. of America, Inc., at 121 W. Wacker Drive. The new office will handle business in Illinois, Indiana, Wisconsin, Kentucky, Tennessee, Missouri, Kansas, Oklahoma, and Michigan.

**Robert Diefendorf** has been elected treasurer of Aluminum Industries, Inc., Cincinnati. Appointed as controller and assistant treasurer of the company in January, 1954, he will continue as controller as well as treasurer.

**Paul H. Hamilton** has been assigned to the Chicago sales territory of Jeffrey Manufacturing Co., Columbus, Ohio. **Guenther Buergel** was assigned to the Detroit sales territory, and **Alva R. Judkins** moves to the Pittsburgh sales territory. All are members of the company's Conveyor Div.

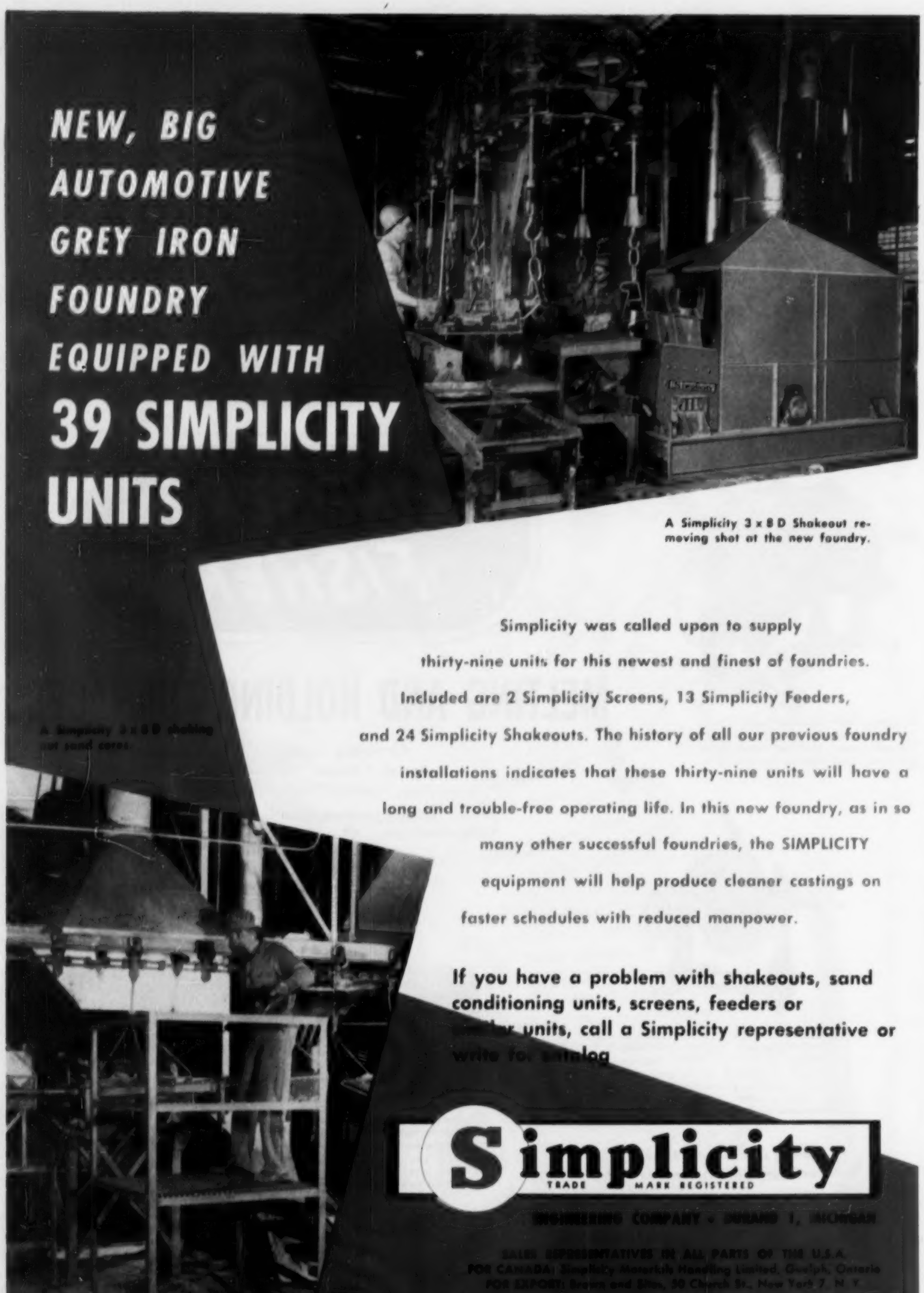
**Harry L. Quinn** has been elected treasurer of Lebanon Steel Foundry, Lebanon, Pa., and **William H. Worrilow, Jr.,** was elected to the newly-created office of vice-president in charge of sales. Mr. Quinn will retain his title as general manager; Worrilow advances from general sales manager. **John H. Boyd** has been appointed general sales manager.

**R. Worth Vaughan** has been elected executive vice-president of American Smelting & Refining Co., and **Oscar S. Straus** was elected vice-president and treasurer.

**G. J. Andres** and **H. C. Colburn** have been appointed to the sales staff of Empire Steel Castings, Inc., Reading, Pa. Before joining Empire, Andres held the position of director of purchases for Fasco Industries in



Circle No. 118, page 83-84




CIRCLE No. 119, PAGE 83-84

Rochester, N. Y. Mr. Colburn was formerly sales manager of Atlas Foundry Co., Irvington, N. J.

**Don Palmisano** has been advanced from service representative to southern sales representative for the Electrode Div., Great Lakes Carbon Corp., New York. His offices will be with J. B. Hayes Co., the Electrode Division's sales agent in Birmingham, Ala.

The board of directors of the Cleveland Quarries Co., has elected **Paul A. Mori** vice-president-opertions. He was superintendent of the Amherst quarries operations.

**Andrew E. St. John** has been appointed technical manager of Barth Smelting Corp., Newark, N. J. He will be in charge of manufacturing operations, technical, and research activities.

**J. D. Robertson,** Decatur, Ga., has been appointed sales engineer for the W. W. Sly Mfg. Co., Cleveland.

**William C. Denison** was elected to the board of directors of American Brake Shoe Co., New York. He is president of the Denison Engineering Co. which was recently purchased by Brake Shoe. **William J. Grant** was appointed southern sales manager for railroad products. He will be in charge of sales for three company divisions, National Bearing, Southern Wheel and Brake Shoe & Castings.

Changes in the sales and service activities of Eastern Clay Products Dept., International Minerals & Chemical Corp., have been announced as follows: **Robert E. Cleland,** formerly Michigan sales manager, has been appointed district sales and service manager for the north central district; **Willis W. Woodman,** formerly sales engineer in the Indiana and southern Ohio territory, has been promoted to district sales and service manager of the South-Central district; **Richard A. Green,** formerly sales engineer for Ohio, has been appointed district sales and service manager for Northern Ohio and Eastern United States; **Willard L. Adams,** formerly sales engineer in Western Michigan, has been made district sales and service manager for the Midwest District.

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## Investment Casters to Hear New Casting Processes Report

Aircraft industry views on investment cast parts and the role of such components in the planes of the future will be told by aircraft manufacturers at the third annual meeting of the Investment Casting Institute in Detroit November 1-3.

ICI President Ted Operhall, Misco Precision Casting Co., will preside at the major business sessions.

**Ted Operhall**

New casting methods such as the Glascast, the Investment "X" and the Ellis processes will be reported on by ICI Consultant N. J. Grant of Massachusetts Institute of Technology. Other topics include *"A Study of Solidification Phenomena"* by R. A. Flinn, University of Michigan, and a talk on the investment casting industry in Europe by Walter Sulzer, Sulzer Bros., Ltd., Winterthur, Switzerland. Investment casting applications in automotive gas turbines will also be covered in one of the meetings.

ICI committees on metal specifications, dimensional tolerances, physical and non-destructive testing, and process materials will hold sessions. A "members only" business will feature a report on investment casting industry sales and business costs.

A drafting and design manual which will analyze the factors affecting tolerances in investment casting is under way.

Information for use in the manual will be obtained by a questionnaire covering all types of design and the tolerances that can be reasonably expected in each sent to every manufacturer of investment castings.

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Please have manufacturer send me without obligation information or bulletins indicated by numbers circled. For unceded advertisements and Here's How items show page numbers on line below.

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# foundry trade news

A half-million dollar expansion and renovation program has been announced by **Acme Aluminum Alloys, Inc.**, Dayton, Ohio. Among the major changes will be the transposing from primarily a foundry to a machine operation.

Contract production of small shell-molded castings of cobalt-base alloys and other non-ferrous and ferrous alloys is offered by **Cobalt, Inc.**, Ann Arbor, Mich. Company has equipment for making shell models up to 14x18 in. pattern size, together with pattern-making facilities, electric arc furnaces and cleaning equipment.

**Combustion Engineering, Inc.**, Chattanooga, Tenn., has announced plans to construct a new and revolutionary type of mechanized foundry for the production of cast iron soil pipe and fittings. The foundry will be constructed at Chattanooga at a cost in excess of 3 million dollars and is expected to be completed in from 15 to 18 months.

**Chambersburg Engineering Co.** has published a booklet giving the history of the company and illustrating and describing some of the products produced.

**Metallurgical Associates, Inc.**, New York, which provides a consulting service aimed at raising the level of the foundry industry, has published a letter describing the Ductaluminum Process, a new process for fabricating dependable high strength alloy aluminum parts.

**Continental Foundry & Machine Co.**, East Chicago, Ind., has announced a 10 per cent increase in the prices of cast iron and steel rolls, effective August 16.

**Ken-Ray Foundry, Inc.**, Vermont Ill., has changed its name to **Ken-Ray Brass Corp.** There will be no other changes in the corporate structure.

Non-Destructive **Testing Dept., Sam Tour & Co., Inc.**, New York has been reorganized for improved and more efficient service. The department will be under the direct supervision of Sam Tour, president of the firm. J. K. Bell, formerly director of the department, is no longer associated with the company.

**Alloy Casting Institute** has issued a paper discussing heat resistant cast alloy properties, which is available on request. Published to aid design engineers in the use of cast heat resistant alloys, paper is entitled *"Heat Resistant Cast High Alloys."*

Award of a $1,700,000 contract for the manufacture of a 15 stand bar mill was announced by the **Birdsboro Steel Foundry & Machine Co.** The new mill was ordered by **Rotary Electric Steel Co.**, Detroit.

**Inductotherm Corp.** has moved from Glenolden, Pa., to a larger plant at 412 Illinois Ave., Delanco, N. J.

**General Electric Co.**, Foundry Dept., Schenectady, N. Y., and **Precision Metalsmiths, Inc.**, Cleveland, have been elected to membership in the **Investment Casting Institute**, Chicago.

**Westinghouse Electric Corp's.** new show entitled "The New Age of Metallurgy" points out the modernization of industrial heating equipment by linking this progress with the advances in the field of metallurgy. Show consists of an oral presentation combined with a full color film-strip projected on a 21-ft vistarama screen. Description of the new metals plant at Blairsville, Pa., is also included.

**Hewitt-Robins, Inc.** has acquired the business, manufacturing facilities and assets of the **W. A. Jones Foundry & Machine Co.**, Chicago, according to an agreement covering the terms of purchase signed by the two companies.

Thirty contracts covering construction and equipment for **Kaiser Aluminum & Chemical Corp's.** new Columbiana, Ohio, basic refractory brick plant have been awarded. Completion of the unit is expected by late spring, 1956.

**Chas. Taylor Sons Co.**, a subsidiary of **National Lead Co.**, is planning a major expansion and improvement of its Taylor, Kentucky, plant. Work will be started immediately on installation of an additional tunnel kiln, continuous dryers, and new grinding, screening and batching equipment.

**Coast Metals, Inc.**, Little Ferry, N. J., has published a folder containing technical data relating to the physical characteristics and uses of wear-resistant castings made of Coast Metals alloys and a list of the production facilities available for castings.

**Archer-Daniels-Midland Co.**, Minneapolis, has announced net profits of $5,749,888, equal to $3.49 a share for its fiscal year ending June 30. This is an improvement of about 15 per cent over the previous year and 49 per cent over two years ago. Sales for the year, excluding grain division transactions, were $221 million, up six per cent from a year ago. Four 50 cents dividends were paid to stockholders during the 12-month period.

**Malleable Founders' Society** has Malleable Iron Facts No. 51 which is available on request. Bulletin lists advantages of pearlitic malleable castings over welded fabrications.

**Morris Bean & Co.**, Yellow Springs, Ohio, has published a booklet describing the Antioch Process for casting aluminum alloy. The Antioch Process is claimed to produce

The Navy recently honored Wheelabrator Corp., Mishawaka, Ind., by presenting a Certificate of Appreciation to the company for its cooperation in giving employees military leave to go on summer training cruises and other training duty. Shown above, Commander I. E. Ayer, commanding officer of the U. S. Naval and Marine Corps Training Center, South Bend, Ind., left, presenting the certificate to Otto A. Pfaff, president and general manager of Wheelabrator Corp., right. Lt. Commander R. E. Gibson, center, a Wheelabrator sales engineer and reserve commanding officer.

castings that meet the most exacting specifications for castings handling fluid flow.

**T. H. Benners Co.,** Birmingham, Ala., is representing **Ayers Mineral Co.,** Zanesville, Ohio, in Mississippi Alabama, Georgia, South Carolina and Florida. Aubrey M. Garrison of Benners is handling the sand sales and service. Eugene Silver, Houston, Texas, is representing Ayers in molding sand sales in Texas.

**Lithium Corp. of America, Inc.,** Minneapolis, has formed a department of product research and development. Walter M. Fenton, formerly sales manager of the company, has been appointed director.

**American Wheelabrator & Equipment Corp.,** Mishawaka, Ind., has moved its district sales offices in Detroit, to 13504 Fenkell Ave. Telephones are VErmont 6-8474 and 6-8475. G. R. Bryant is district manager for the Detroit office. W. A. Illsley, F. H. Smith, and J. W. Swantz are district sales engineers. R. D. Haworth, Jr., and Leo O'Brien are abrasives engineers. D. W. Miller is district service engineer.

**Consolidated Foundries & Mfg. Corp.,** Chicago, has acquired **Consolidated Foundries, Inc.,** and **Iowa-Michigan Corp.** Consolidated Foundries, Inc., operates four divisions: **Crucible Steel Casting Co.,** Milwaukee; **Michigan Steel Cast-Co.,** Detroit; **Western Foundry Co.,** Holland, Mich.; and **Ebaloy Foundries Co.,** Rockford, Ill. Iowa-Michigan Corp. operates two divisions: **Misco Precision Casting Co.,** with plants in Detroit and Whitehall, Mich., and **Iowa Soap Co.,** Burlington, Iowa. Consolidated Corp. also acquired United States Brewing Co. and Available Truck Co.

**Los Angeles Steel Casting Co.,** Los Angeles, has published a four-page folder illustrating operations in the production of quality steel castings.

**Continental Foundry & Machine Co.,** East Chicago, Ind., has purchased a 14-story building, together with an adjoining four-story building, in Pittsburgh.

## Markets & Management Tools Headline SFSA Meeting

■ "A Healthy Steel Foundry Future" is the theme of the 53rd fall meeting of the Steel Founders' Society of America to be held at The Greenbrier, White Sulphur Springs, W. Va., October 24 and 25. SFSA President A. J. McDonald, American Steel Foundries, Chicago, will preside. He will open the two-day meeting with a talk, *"Half the Battle,"* covering functions and future plans of the society as recommended by the group's Program Appraisal Committee.

A. J. McDonald

Executive Vice-President F. Kermit Donaldson will speak on *"Executive Responsibility in Today's Business World"* and Chauncey Belknap, SFSA legal counsel, will discuss legal developments affecting steel castings producers. How top management can use ratios of the castings industry as a business control tool will be told by Roy A. Foulke, Dun & Bradstreet, New York.

A banquet will conclude the first day's activities.

Market for steel castings will be covered the morning of October 25 when the Steel Founders' market development program will be discussed. Safety awards for zero frequency and for outstanding records in each of four manhour classifications will be awarded to winners in the society's 1955 Safety Contest.

MORE FACTS on all products, literature, and services shown in the advertisements and listed in Products & Processes and in For the Asking can be obtained by using the handy Reader Service cards, pages 83-84.

# local foundry facts

## Chesapeake Forms Southern Section

At a recent organizational meeting for the Southern Section of the Cheaspeake Chapter of the American Foundrymen's Society, T. W. Curry, director of research, Lynchburg Foundry Co., was elected temporary section chairman.

Serving with Curry will be D. E. Matthieu, Kerchner, Marshall & Co., secretary; J. Scott Parrish, Jr., Richmond Foundry & Mfg. Co., program committee chairman, and G. C. Cole, Wysong Miles Foundry, Inc., chairman of membership committee.

The meeting was the first step in organizing the Southern Section of the Chesapeake Chapter which is to include Virginia, North Carolina and eastern section of West Virginia. Need was felt for breaking down the Chesapeake Chapter in an effort to get a greater exchange of technical information in the southern section, Curry said.

At the meeting the 18 representatives of the section scheduled a second organizational meeting September 23 in Newport News, Va., in conjunction with the Chesapeake Chapter. Both groups planned to visit the Newport News Shipbuilding and Drydock Co. during their stay.

Representatives at the first meeting were, Curry, Matthieu, Parrish,

THE NEWS, LYNCHBURG, VA.

**Chesapeake** . . Principals of the first organizational meeting for the Southern Section of the Chesapeake Chapter of AFS check over the list of representatives who attended the dinner session at the Virginia Hotel. From left to right: Lewis H. Gross, American Standard Corp.; T. W. Curry, Lynchburg Foundry Co., temporary section chairman; D. E. Matthieu, Richmond, temporary secretary, and D. J. Hayes, National AFS Headquarters.

Cole, Dr. J. K. Sprinkle and Dr. M. V. Nevitt of the metallurgy department, Virginia Polytechnical Institute; Frank G. Carrington, Glamorgan Pipe & Foundry Co.; Joe Kieth, White Foundry Co., Roanoke; C. M. Eckman, Virginia Metalcrafters, Inc., Waynesboro; Earl Swenson, Ironton Fire Brick Co.; Larson E. Wile and Harvey E. Henderson, Lynchburg Foundry Co.; D. J. Hayes, AFS National Headquarters representative; J. O. Danko, Danko Pattern Mfg. Co., Baltimore, Md.; Jack H. Schaum, National Bureau of Standards, Washington, D. C.; Lewis H. Gross, American Standard Corp., Baltimore; S. W. Richard, Richard Machine Works, Norfolk, and L. A. Howell, Newport News Shipbuilding & Drydock Co.

### Philadelphia

More than 550 members and guests were present at the annual summer outing held at the Manufacturers Golf and Country Club in July.

A golf tournament, softball game, quoits and swimming were the order of the day. In the annual softball game, once again the "pedlers" and the "foundrymen" tangled, and as yet no one knows the final score. *—Charles R. Sweeny.*

### Northwestern Pennsylvania

An organizational meeting of the officers and directors who have been elected to serve for the coming year was held recently. Attending were: Jacob Dimert, Erie Castings Co., chairman; Robert Johnson, Bucyrus Erie Corp., co-chairman; E. J. Bonesteel, General Electric Co., secretary, and Richard Strong, Griswold Mfg. Co., treasurer.

Directors present were: Roy A. Loder, Erie Malleable Iron Co.; Walter Yahn, American Sterilizer Co.; W. Clemons, Meadville Malleable Iron Co.; Paul Green, General Electric Co; O. C. Bueg, Arrow Pattern Works; R. Erskine, Bucyrus Erie Corp., and A. Whiteman, Lakes Laboratory.

Committees appointed at the meeting included: *Educational*, P. W. Green, chairman; W. Peelman, Earl Strick, W. Eccles, J. Clark and A. Whitemen. *Publicity*, W. Yahn, chairman; B. Her-

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WALTER NAFP, DELTA OIL CO.

**Wisconsin** . . Chapter President R. V. Osborn, presenting his father, W. V. Osborn, with one of chapter's 50-year plaques.

rington and R. Loder. *Membership,* O. C. Bueg, chairman; H. Haus, W. Miller, B. Roth and R. Almstead, with a committee member in each plant represented. *Advisory,* B. Herrington, chairman, R. Griswold, E. Strick, C. Gottschalk, J. Clark, J. Hornstein, J. Shuffstall, F. Volgstadt, D. James and F. Carlson. *Entertainment,* J. Considine, chairman, R. Humphries, S. Walkiewicz, H. Dimert, J. Nardo, F. Carlson, F. Harter and J. Pace.

**St. Louis**

Over 250 members and guests attended the annual picnic of the chapter at Lemay Grove in St. Louis County, in August. Jack H. Thompson, East St. Louis Castings Co., was entertainment chairman.

Highlight of the afternoon was a foundrymen vs. suppliers softball game in which the foundrymen trounced the suppliers by the wide margin of 16 to 15. —*Jack Bodine.*

**Tennessee**

New officers and directors elected for the coming year are as follows: William P. Grieser, Ross-Meehan Foundries, *chairman;* Herman Bohr, Robbins, & Bohr, *vice-chairman;* Hal Roach, Laclede-Christy Co., *secretary,* and W. F. Hetzler, Eureka Foundry Co., *treasurer.*

Board of Directors include: Tink Johnson, Somerville Iron Works; C. Chisolm, Wheland Co.; R. H. Barker, U. S. Pipe & Foundry Co., Marion Guenther, Strickland Pattern Works; John A. Lasater, Combustion Engineering Co., Inc.; Richard Kellerman, Lodge Mfg. Co.; G. Frank Anderson, Tennessee Products & Chemical Corp., and W. L. Austin, U. S. Pipe & Foundry Co. —*Joseph F. Delaney.*



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## afs chapter meetings

OCTOBER

5 . . Central Illinois . . Legion Hall, Peoria. Don M. Gerlinger, Walter Gerlinger, Inc., *"Shell Cores."*

5 . . Chicago . . Bar Association. Hans J. Heine, American Foundrymen's Society, and Roy Carver, Carver Foundry Products Co., *"The Carbon Dioxide Process"* and $CO_2$ Process movie.

5 . . Cincinnati District . . Anthony Wayne Hotel, Hamilton. Zigmond Madacey, Beardsley & Piper Div., Pettibone Mulliken Corp., *"Tricks in Core Blowing."*

5 . . Metropolitan . . Essex House Hotel, Newark. Dorian Shainin, Rath & Strong, Inc., *"Quality Control in Foundry Operations."*

5 . . Western Michigan . . Bill Stern's, Muskegon. Ralph L. Lee, *"The Metallurgy of Human Beings."*

5 . . Toledo . . Toledo Yacht Club. Joseph S. Schumacher, Hill & Griffith Co., *"Fool Proof Sand"* and $CO_2$ Process movie.

*6 . . Saginaw Valley*
Fischer's Hotel, Frankenmuth, Mich. Mead Killion, *"Human Behavior Factors."*

*6 . . Canton District*
Canton, Ohio. Carl O. Schopp, Link-Belt Co., Indianapolis, *"Shell Molding."*

7 . . Philadelphia . . Engineers' Club. W. B. Coleman Lecture—Harry W. Dietert, Harry W. Dietert Co., *"Processing Molding Sand."*

7 . . Southern California . . Rodger Young Auditorium, Los Angeles. Two afternoon and two evening sessions. Hans J. Heine, American Foundrymen's Society, *"New Horizons in Foundry Progress;" "Quality Control in the Foundry"* in cooperation with Charles Locke, Westlectric Castings, Inc., and F. S. Brewster, Brumley-Donaldson Co.; *"Vertical Gating"* plus AFS Vertical Gating movie; and *"New Approach to Improvement of Casting Design."*

*10 . . Michiana*
Whitcomb Hotel, St. Joseph, Mich. J. A. Westover, Consulting Engineer, *"Casting Cost Estimating."*

10 . . Northern California . . Shattuck Hotel, Berkeley. Two evening sessions. Hans J. Heine, American Foundrymen's Society, *"Casting Design"* and *"Vertical Gating"* plus AFS Vertical Gating movie.

11 . . Twin City . . Covered Wagon, Minneapolis. C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., *"Mechanization in Small Foundries"* plus movie on the subject.

13 . . Northeastern Ohio . . Tudor Arms Hotel, Cleveland. Patternmaking: C. W. Forestek, Forestek Plating & Mfg. Co., *"Hard Chrome Plating of Aluminum;"* Non-Ferrous: Walter E. Sicha, Aluminum Co. of America, *"A Study of Vertical Gating Design"* plus AFS Vertical Gating movie; Ferrous: Charles Schneider, National Malleable & Steel Castings Co., *"Developing New Ferrous Casting Business."*

14 . . Eastern Canada . . Mount Royal Hotel, Montreal. John Perkins, Ford Motor Co. of Canada, Ltd., *"Modern Foundry Practice."*

14-15 . . New England Regional Foundry Conference, Massachusetts Institute of Technology, Cambridge. *Sponsored by the New England Foundrymen's Association in cooperation with MIT.*

14-15 . . Northwest Regional Foundry Conference . . Multnomah Hotel, Portland Oregon. *Sponsored by the British Columbia, Oregon, and Washington Chapters and the Oregon State College Student Chapter.*

20-21 . . Ohio Regional Foundry Conference, Case Institute of Technology, Cleveland. *Sponsored by the Canton District, Central Ohio, Cincinnati District, Northeastern Ohio, and Toledo Chapters of the American Foundrymen's Society.*

20 . . Detroit . . Hotel Tuller. Panel meeting. C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., and L. A. Danse, *"Foundry Equipment Maintenance."*

21 . . Birmingham . . Tutwiler Hotel. *"Top Management Night."*

21 . . Central New York . . Mark Twain Hotel, Elmira. C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., *"Mechanization in Small Foundries"* plus movie on the subject.

28 . . Chesapeake . . Engineers' Club, Baltimore. Thomas E. Barlow, Eastern Clay Products Dept., Int'l. Minerals & Chemical Corp., *"Pressure Molding."*

28 . . Tennessee . . Hotel Patten, Chattanooga. C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., *"Mechanization in Small Foundries"* plus movie on the subject.

28 . . Texas . . Menger Hotel, San Antonio. J. P. Hunter, Texas Foundries, Inc., *"Safety Practices for Foundries"* and panel discussion.

NOVEMBER

1 . . Twin City . . Calhoun Beach Club, Minneapolis. AFS-ASM joint meeting. Speaker from Do-ALL Co. on *"Civilization Through Tools."*

3-4 . . Metals Casting Conference, Purdue University, West Lafayette, Ind. *Sponsored by the Central Indiana and Michiana Chapters of the American Foundrymen's Society.*

4 . . Birmingham District . . Anniston. Panel discussion on Soil Pipe.

7 . . Western Michigan . . Grand Rapids. Roy Carver, Carver Foundry Products Co., *"$CO_2$ Core Process."*

## obituaries

**Gosta Vennerholm**, manager of the manufacturing research department, Ford Motor Co., passed away September 9.

Born in Stockholm, Sweden, he moved to the United States in 1924 and joined Ford in the same year as a chemist at the Highland Park plant. From 1925-27 he served as an instructor at the Henry Ford Trade School in Dearborn and worked at Dagenham, England, as supervisor in the reorganization of the foundries of the Ford Motor Co. in England and Europe from 1933-38.

G. Vennerholm.

Returning to the Rouge plant, Mr. Vennerholm served in several supervisory metallurgical posts. During World War II, he worked on numerous war engineering committees. He was named manager of the manufacturing research department in June, 1954, after having been assistant manager for several years. During his Ford career, he directed many of the company's chemical and metallurgical developments.

Mr. Vennerholm held the McFadden Gold Medal of the American Foundrymen's Society, has served on many AFS committees and was chairman of the Annual Lecture Committee. At the time of his death he was a member of the Advisory Group of the Steel Div. and a member of the Cupola Research Committee. He also contributed greatly to the AFS publication, Cupola Handbook. He was also active in the Society of Automotive Engineers, American Society of Metals, and the American Ordnance Association.

**Francis Joseph Stokes**, 81, chairman of the board of F. J. Stokes Machine Co., Inc., Philadelphia, died recently in Germantown, Pa.

**Harold L. Martin**, vice-president and general manager of Atlas Foundry & Machine Co., Richmond, Calif., died recently.

**Herbert J. French**, 62, vice-president of the International Nickel Co., Inc., and assistant vice-president of the International Nickel Co. of Canada, Ltd., died recently in Rochester, Minn.

**Richard Samuel Reynolds**, 73, founder of the Reynolds Metals Co., died recently at his home in Richmond, Va.

**Ward M. Huston**, president of the Xenia Foundry & Machine Co., Xenia, Ohio, died recently.

# SPECIAL OFFERING!!

## FOUNDRY EQUIPMENT

ORIGINAL COST: $250,000.00

SAVINGS OFFERED: 40 TO 90%!!

### LATE MODEL (1949-1953) EQUIPMENT – FULLY GUARANTEED

**AIR COMPRESSORS**
1—INGERSOLL-RAND Type ES1, 300 CFM, size 11 x 12, with air tank 3' x 8'.

**CORE BLOWERS**
1—DEMMLER No. 2 with air clamps.
1—DEMMLER No. 4, with air clamps.

**CORE ROD STRAIGHTENERS**
1—AMERICAN Style R Core Rod Straightener & Shear, 2½" cap.
1—CLIMAX No. 3 Wire Straightener.
1—TRIMMER Model I Sprue Cutter, 1¼" dia., 5 HP motor.

**CORE OVENS**
1—INDUSTRIAL Continuous Type, trays 18" x 60" long, 24" center; overall dimensions 110" wide, 83" high, 74" deep; gas fired, recirculating. New 1952.

**CUPOLA & ACCESSORIES**
1—BASIC REFRACTORIES BRI Gun, Model A16, (Similar to Bondactor)
1—FOXBORO Air Weight Controller.
1—MAUCK Lighter Tank & Torch.
1—WHITING No. 6 Cupola.
1—ROOTS CONNERSVILLE Rotary Positive Blower, size 5½, with 40 HP motor.

**MOLDING MACHINES**
1—INTERNATIONAL Type G Jolt Rollover Pattern Draw, Size 24 x 16.
1—JOHNSON & JENNINGS 642RB Jolt Roll-over Pattern Draw, table 24" x 30", 12" draw, 600 lb cap., portable.
1—MILWAUKEE No. 107 Jolt Squeeze Rollover Draw, Sask 22" x 33", 12" draw, 18" squeeze, 1000 lb. jolt.
1—MILWAUKEE No. 1536 Jolt Pin Lift table 22" x 36", 1500 lb. jolt, 12" draw.
7—OSBORN No. 212 Jolt Squeezers, 12" cyl-inder, 17" x 26" table.
1—OSBORN 710PV Vibrating Jolt Squeeze Pin Lift, table 16" x 26", 6" draw.
2—TABOR 30" x 40" Shockless Jar Rollover Pattern Draw.
2—TABOR 42" x 32" Shockless Jar Rollover Pattern Draw.

**MELTING LADLES**
2—MODERN F-9 Pouring Devices.
6—WHITING Enclosed Gearing, V-bail ½ to 10 ton capacity.

**MATERIAL HANDLING EQUIPMENT**
104—INGERSOLL-RAND RC-5 Air Bloc Hoists, 500 cap., with roller chain, buckets, pendant throttle controlled.
25—INGERSOLL-RAND Air Hoists, Sizes A, B, D, D-6 and E, 500 to 10,000 lb.
1—ELECTRIC BRIDGE CRANE, 25' span, with 2 ton Robbins & Meyers Hoist, with 150' of 12" I-beam runways.
1—JEFFREY Trough Belt Conveyor, 75' cen-ters, belt 24" wide, 4 ply.
1—JEFFREY Trough Belt Conveyor, 160' cen-ters, belt 24" wide, 4 ply, with 18" x 24" face high duty magnetic pulley.
3—LOUDEN MONORAIL SYSTEMS, "Super Track" (1) 110' of 6" I-beam & two 20' bridges (2) 140' of 6" I-beam & two 12' bridges (3) 130' of 11" I-beam & two 35' bridges; all complete with trolleys and hangers, etc.
1—Power Crane, 25' span, with power trolley, 120' runways, 12" beam.
1—SIMPLICITY Model OA-10-JA Vibrating Conveyor, 24" wide x 16' long x 8" deep.

**ROTO-CLONE DUST COLLECTORS**
1—AMERICAN AIR FILTER Type N, Size 20, 20,000 CFM, 75 HP motor and fan.
1—AMERICAN AIR FILTER Type N, Size 24, 24,000 CFM, 75 HP motor and fan.

**SAND MULLERS**
1—SIMPSON No. 2 Muller, Style B, with skip hoist.
1—SIMPSON No. 2F, Style UD, 80" pan dia., 2000 lb. batch size, with 30 HP motor, skip hoist, aerator, water meter.
1—SIMPSON No. 1½ Muller, Style UD, with skip hoist, etc.
1—SIMPSON No. 1½ Muller, Style B, separate drive, with skip hoist.
1—CLEARFIELD No. 404 Muller, 4 cu. ft. batch size.
1—CLEARFIELD No. 930 Muller, 30 to 40 cu. ft. batch size.

**SAND PREPARATORS**
1—AMERICAN Sand Cutter, Model AA, 6' 0", Serial No. 643, power all around.
1—AMERICAN Model M Sand Cutter, Size 80/70.
1—AMERICAN Model M Sand Cutter, Size 90/80.
6—BEARDSLEY & PIPER Models S, M and L Screenerators.
8—ROYER Sand Conditioners, all models, Jr., NC-2, NDP, C-2 etc., portable.

**SCALES**
1—FAIRBANKS MORSE Open Dial, 4' x 5' platform, 6000 lb. capacity, springless.
1—TOLEDO Open Dial, 4' x 5' platform, 6250 lb. capacity, Model 31-1541-PC.

**TUMBLING BARRELS**
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**FOUNDRY ASSISTANT** needed by captive gray iron foundry of medium size heavy process machinery manufacturer. Young college engineer graduate preferred. Should have had some foundry experience. Is to help increase plant efficiency, planning, research and operation. Company has liberal profit sharing plan. Salary open. Location S. E. Penna. Reply **Box C65, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

**FOUNDRY TECHNICIAN.** An Eastern Canadian Mechanized Foundry has an opening for a Foundry Technician as a trouble shooter. He should have experience in pattern making, gating, layout and general foundry techniques for Brass and Bronze castings. Some snap-flask experience would be beneficial. Salary will depend on qualifications. **Box C64, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

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**SALESMAN,** well-established refractory company wishes experienced melting foundryman located in Detroit area to cover Michigan and parts of Indiana. **Box C63, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

**MOLDING FOREMAN** or Assistant. Mechanized Midwest Foundry wants aggressive foreman for molding department. Give personal history, references, and salary. **Box C69, MODERN CASTINGS, Golf and Wolf Roads, Des Plaines, Ill.**

## Build Torsion Impact Tester

A new improved torsion testing machine built to fulfill requirements of the Army Ordnance Corps and designed by Pitman-Dunn Laboratories is described in a research report just released by the Office of Technical Services, U. S. Department of Commerce.

The new Kinetic Torsion Impact Tester not only produces shear fractures, but permits accurate determining and recording of energy and torque values and indicates how the applied torques and the specimen's resistance fluctuate during testing.

Methods of measuring energy and twist required to fracture, torque, and torque vs. time to fracture are detailed in the report, with photographs and diagrams of the devices used and their operation.

This research report, PB 111613 *Improved Method for Testing in Torsion Impact,* may be obtained from OTS, U. S. Department of Commerce, Washington 25, D. C., for 75 cents.

## advertisers and their agencies



## What About Foundry Noise?

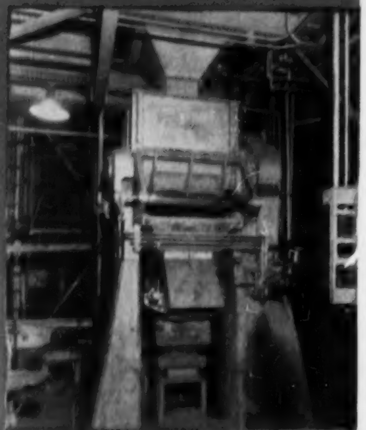
What noise is, what it does, where it comes from, and what the foundryman can do about it is essentially the content of the American Foundrymen's Society proposed manual on noise.

AFS Noise Committee 10-M-a, meeting recently in Chicago with Chairman Herbert T. Walworth, Lumbermen's Mutual Casualty Co., assigned the following titles to sections of the manual: What is Noise? Physiological Effects of Noise; Compensation Trends of Hearing Loss; Evaluation of Hearing; How to Measure Noise; Foundry Exposures to Noise; Engineering Control of Noise; Medical Control of Noise; and Personal Protective Equipment.

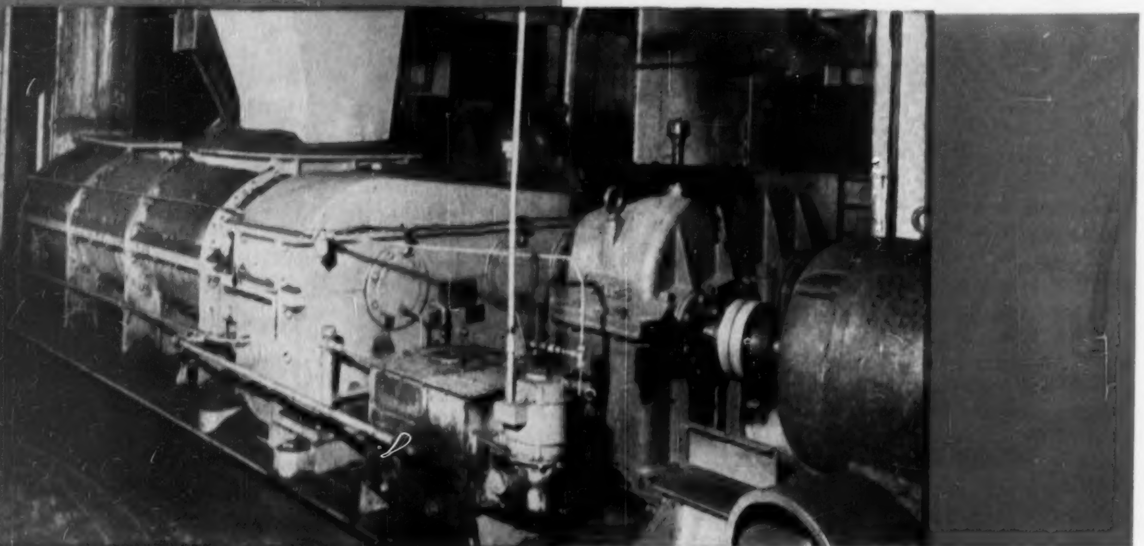
## Plan German Foundry Fair

The 1956 GIFA International Foundry Trade Fair will be held in Düsseldorf, Germany, September 1-9, 1956. This will be the first time in 20 years that a Foundry Trade Fair has coincided with an International Foundry Congress. With this trade fair, the German foundry industry intends to bring castings, as raw materials, to the attention of interested persons both at home and abroad.

Additional information may be obtained by writing Nordwestdeutsche Ausstellungs-Gesellschaft mbH, (NOWEA), Düsseldorf, Ehrenhof 4, Germany.









### Helps Small Businesses

Bulletins of interest to foundrymen such as maintenance of power hand tools, how to select the right grinding wheel, fire prevention in small business, gas welding of cast iron, use of templates and scale models in plant layout, preventive maintenance for the small plant, care and maintenance of grinding wheels, and others, are being published by the Small Business Administration.

"Technical Aids for Small Business," published monthly as a 4-page bulletin, deals with a single subject each month. Copies of these bulletins and a list of those available may be obtained by writing to the Small Business Administration, Washington 25, D. C.

### Radiation Manual Due

Safe practices for handling x-ray and radioactive isotopes will be the subject of a manual to be prepared by a special committee of the American Foundrymen's Society.

Besides making arrangements for this manual, the Safety, Hygeine, and Air Pollution Control Steering Committee of AFS meeting in Chicago July 27-28, also reviewed activities of the Welding Committee. The forthcoming "Welding Manual" will include all matters of health and safety pertaining to welding.

Tentative arrangements for participation in the 1956 AFS Castings Congress and Exhibit at Atlantic City include three technical sessions and a display booth.

### List Equipment Speakers

A revised and up-to-date speakers list has been compiled by the Foundry Equipment Manufacturers Association, Inc. All speakers on the list are qualified and available to discuss various foundry subjects at management group meetings.

Copies of the list may be obtained by writing Foundry Equipment Manufacturers Association, Inc., One Thomas Circle, Washington, D. C.

### Develop Molding Sand Book

Perhaps the most complete summary of present knowledge of sand molding will be contained in the forthcoming book *Molding Sand Practice* being developed by the Sand Handbook Revision Committee of the American Foundrymen's Society.

Heretofore, sand practice has been treated only as a portion of books covering the entire broad foundry field. Special procedures of sand testing practice, on the other hand, are covered in the comprehensive AFS FOUNDRY SAND HANDBOOK, which is limited to testing only.

The new book will include general aspects of sand testing to determine mold properties and should not be confused with the testing reference.

The scope of this 8¼ x 11¼-in. (AFS TRANSACTION's size) book is indicated by the following tentative table of contents:

*Preface*
*Types of Mold*
*Sand, Shell, Investment, Cement, Plaster, Permanent, Other* (ceramic, graphite, glass, etc)
*Molding Materials*
*Sands:* Silica (bonded, unbonded), Zircon, Other (olivine, coke, graphite, chamotte, calcined clays, etc)
*Inorganic Bonds, Organic Bonds, Additives, Water, Coatings,* and *Partings*
*Sand Preparation Equipment*
*Mixing:* Muller, Blade Mixer, Blender, Cutter, Others
*Auxiliary Equipment:* Aerator, Magnetic Separator, Cooling Devices, Dust Control, Screening
*Sand Reclamation*
*Sand Storage* (silo, bin, box)
*Preparation of Sand*
*Selection of Ingredients, Proportioning* (formulas), *Mixing*
*Properties and Interpretation*
*Base Properties:* Physical (grain size, shape, distribution), Chemical (pH, etc)
*Green, Air-set, Dry, Hot,* and *Retained Properties*
*Mold Properties* (room and elevated temperatures)
*Typical Sand Practice*
*Ferrous* (Production: automotive, agricultural, hardware, etc; Jobbing: light, medium, heavy) Gray Iron, Malleable, Nodular, Steel
*Non-ferrous:* Copper-base, Light metals, Others
*Glossary of Terms*
*References and Bibliography*
*Index*



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